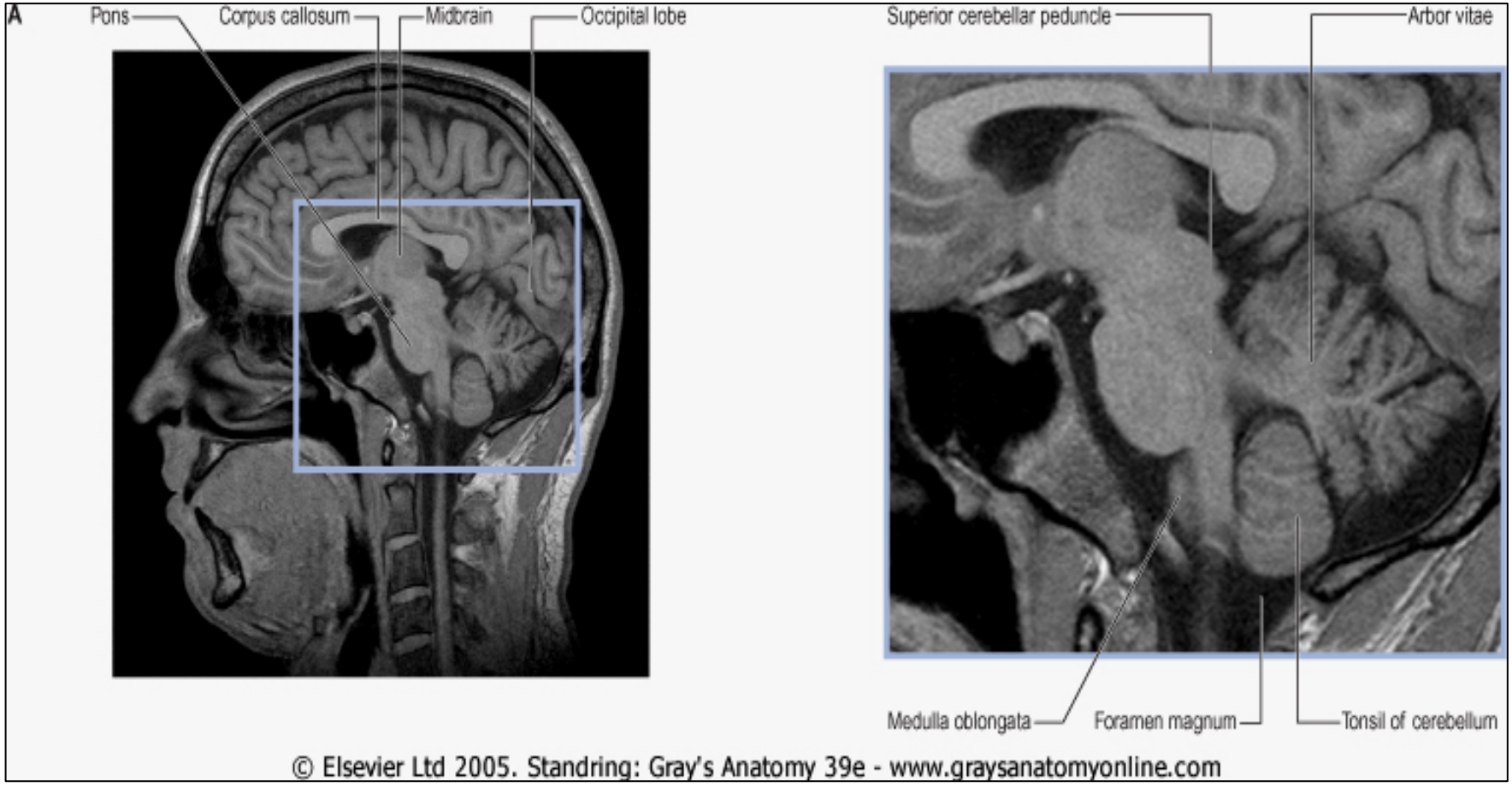
Cerebellum

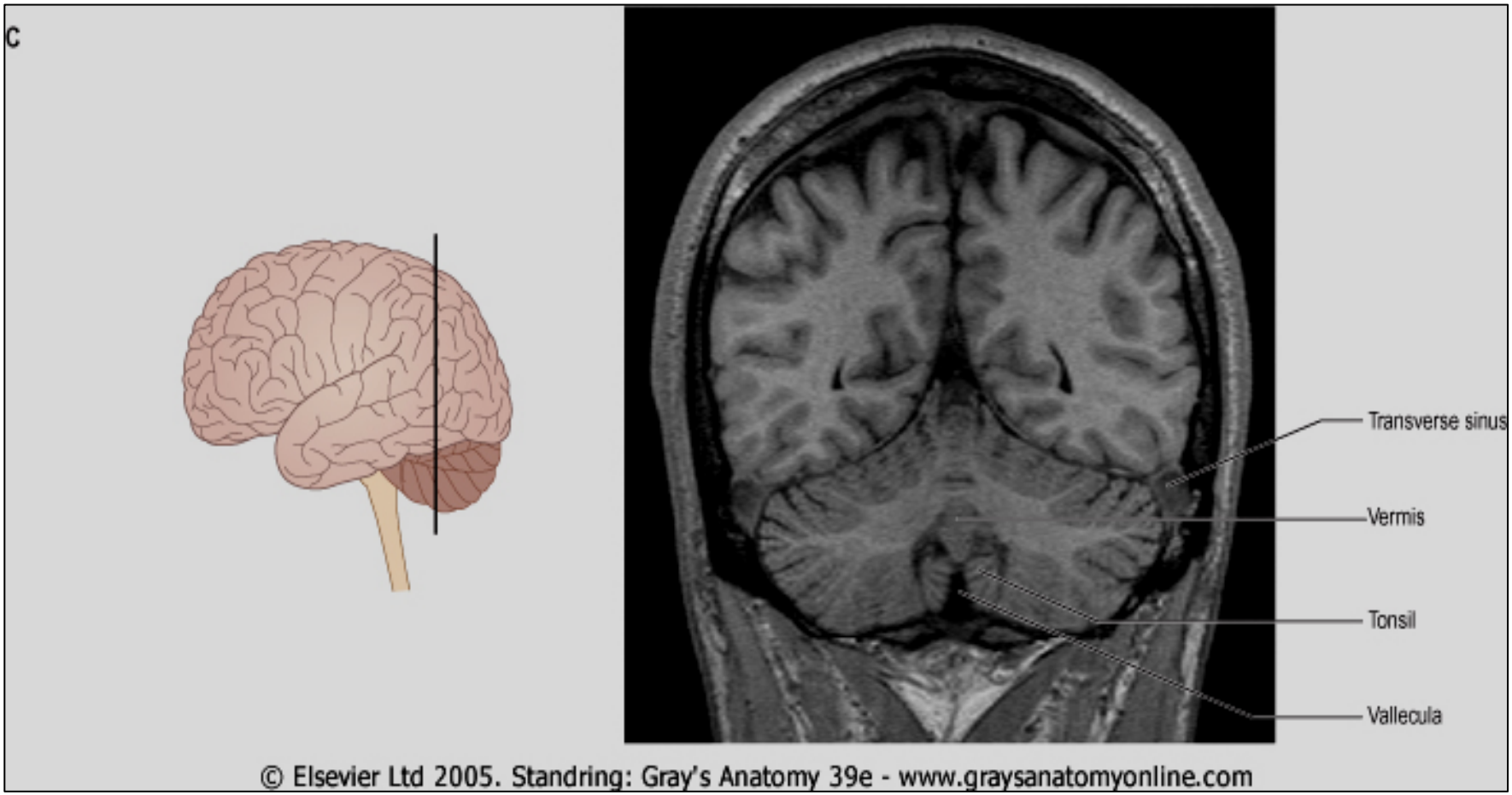
By

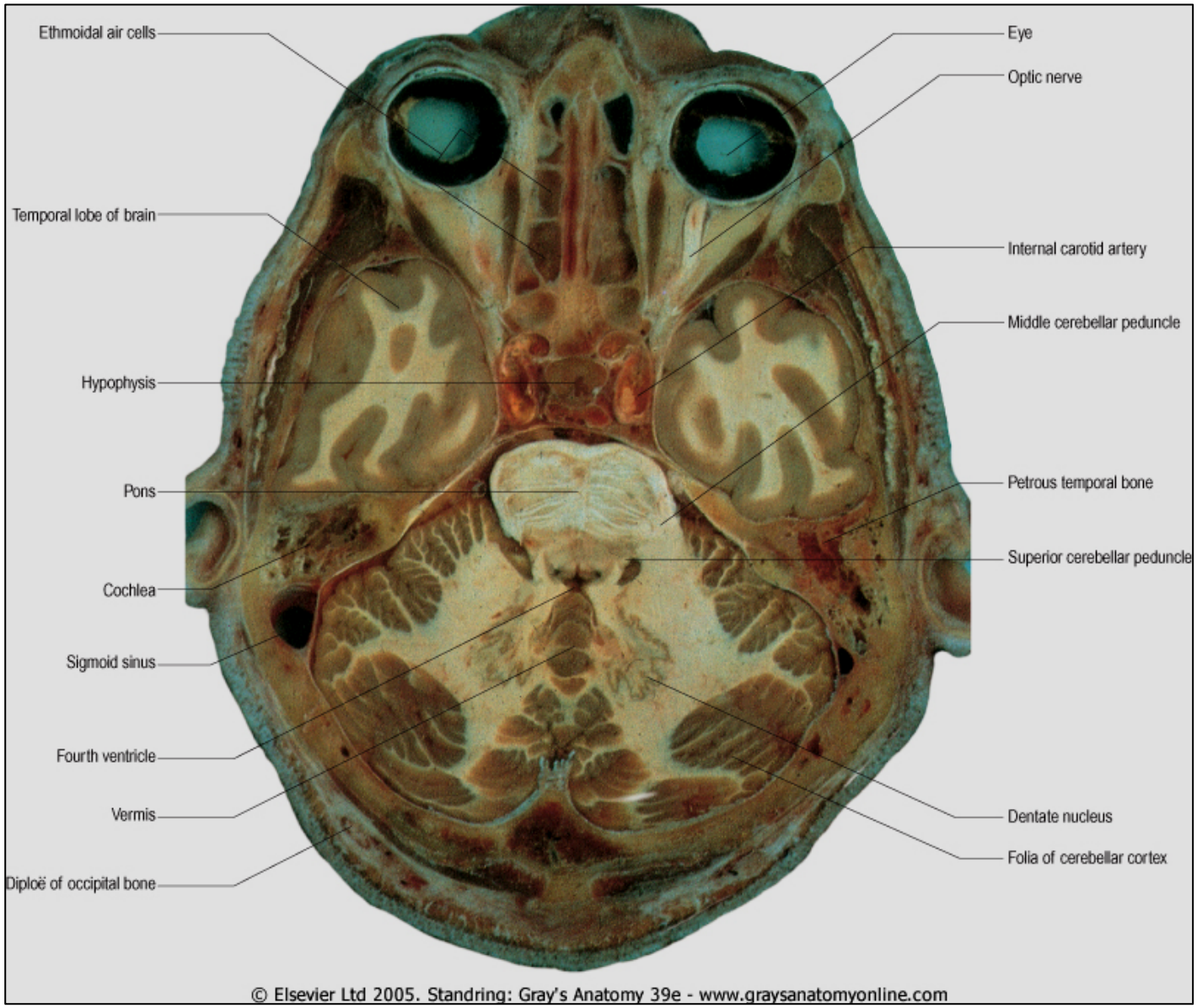
Dr. Noura El Tahawy

Magnetic resonance images of the cerebellum of a 16-year-old female. A, sagittal slice.



Magnetic resonance images of the cerebellum of a 16-year-old female. coronal slice. C,





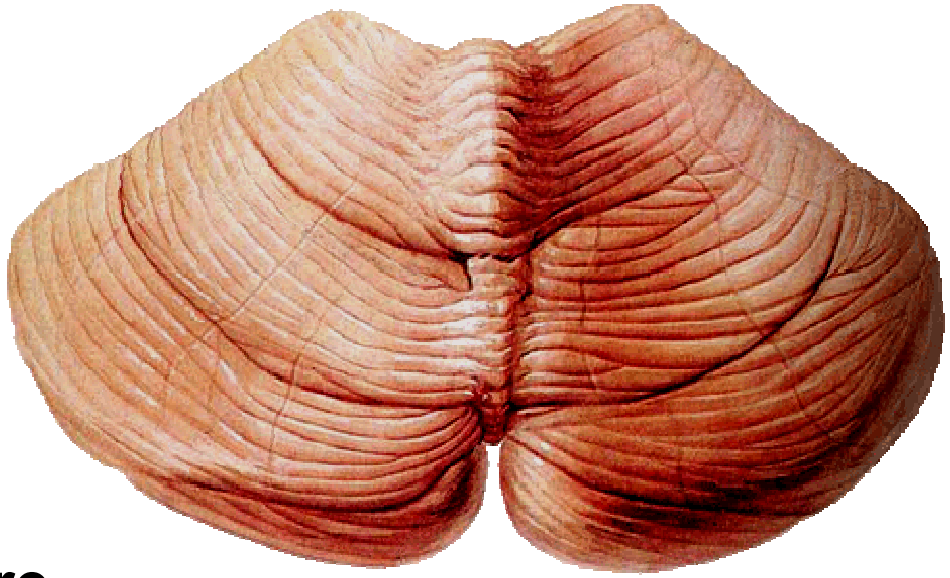
Horizontal section through the cerebellum and brain stem.

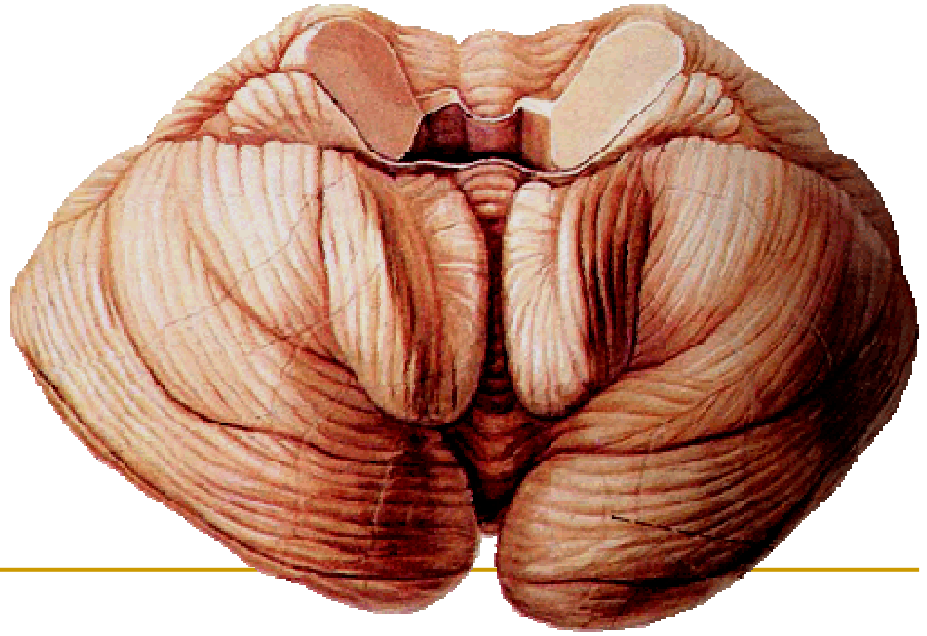
Lobs

- Three deep fissures
  - **Primary fissure**
  - **Horizontal fissure**
  - **Posterolateral fissure**

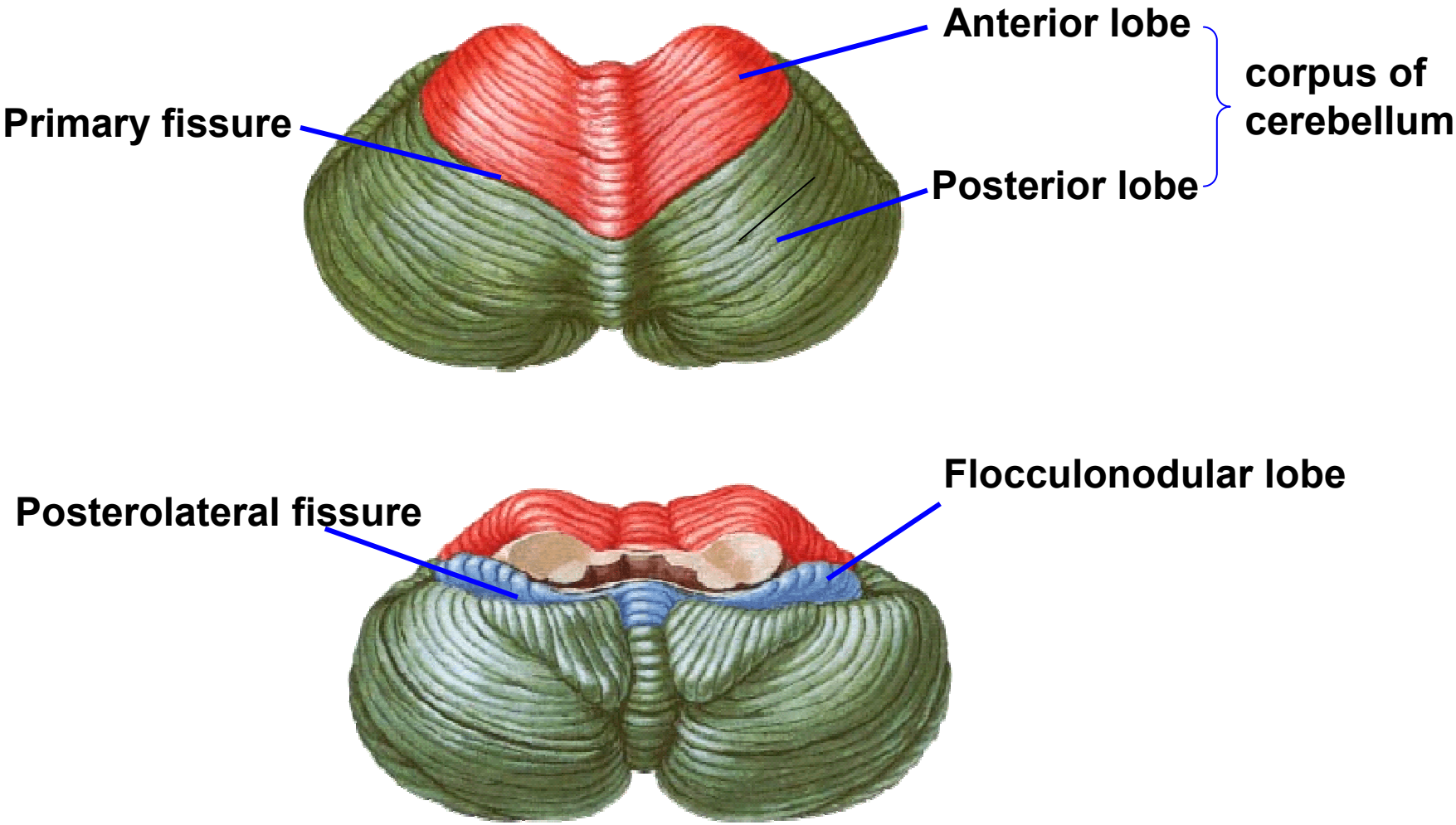
    Three lobs
  - **Flocculonodular lobe**

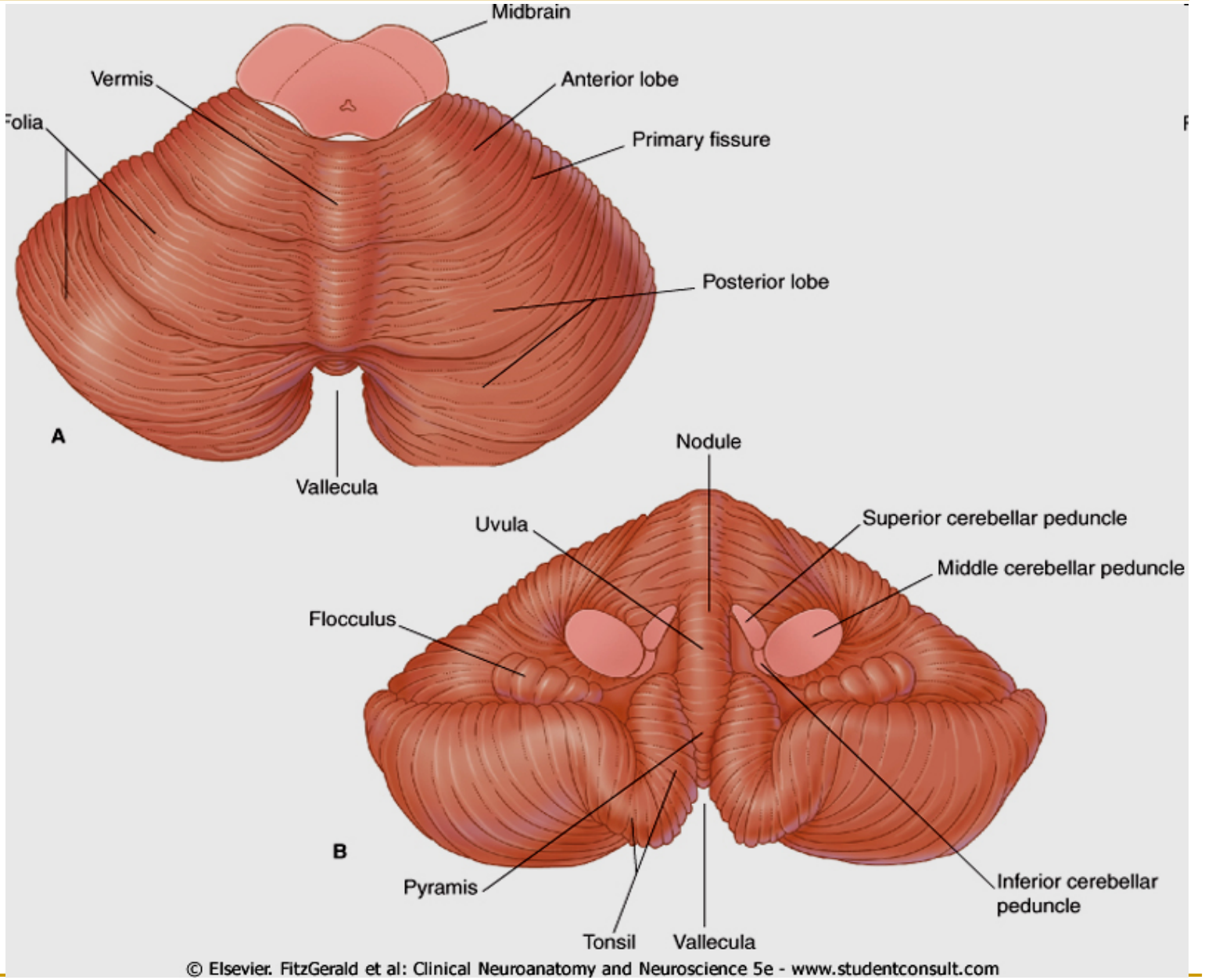
    flocculus and nodule
  - **Anterior lobe**
  - **Posterior lobe**



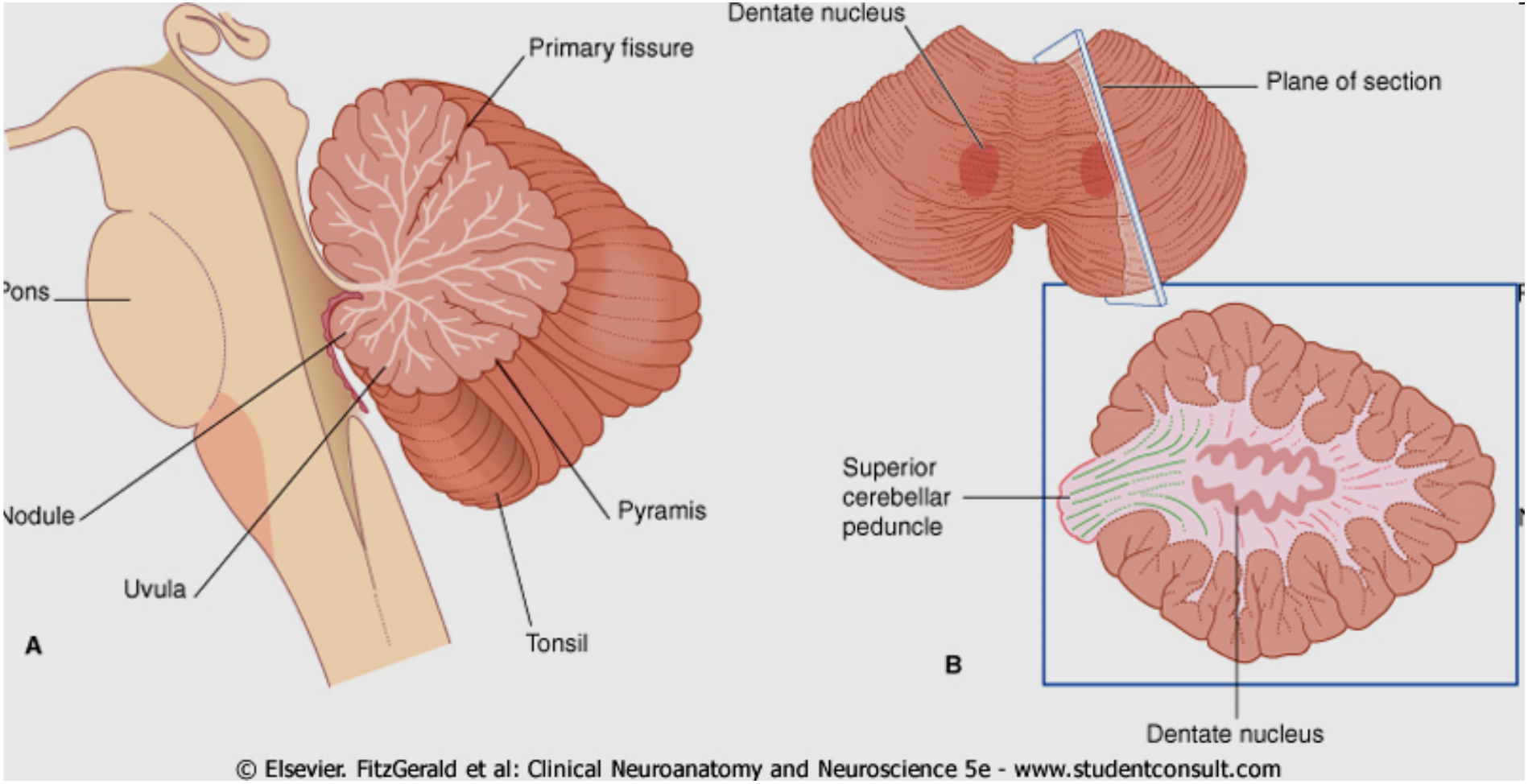


Lobs


Anterior lobe
corpus of cerebellum
Primary fissure
Posterior lobe
Flocculonodular lobe
Posterolateral fissure



Cerebellum) .**A** Viewed from above **B** Viewed from the position of the pons .



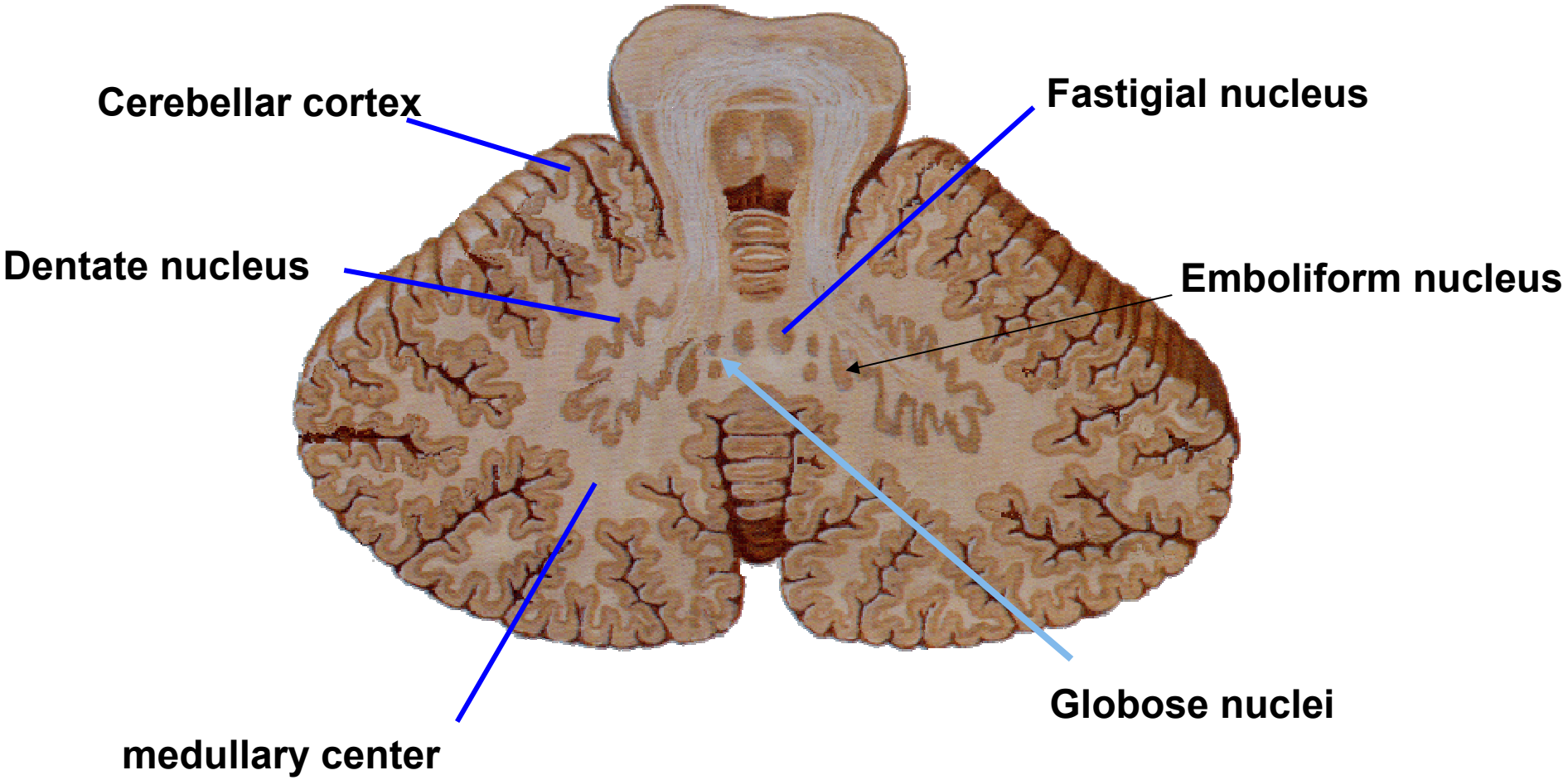
A Sagittal section of hindbrain .**B** Oblique section of cerebellum .

Internal structure

Gray matter

- **Cerebellar cortex**
- **Cerebellar Medulla (White matter)**
- **Cerebellar nuclei**
  - Dentate nucleus,
  - Fastigial nucleus,
  - Emboliform nucleus
  - Globose nucleus

Internal structure



Cerebellum — Internal Configurations

Cerebellar Cortex

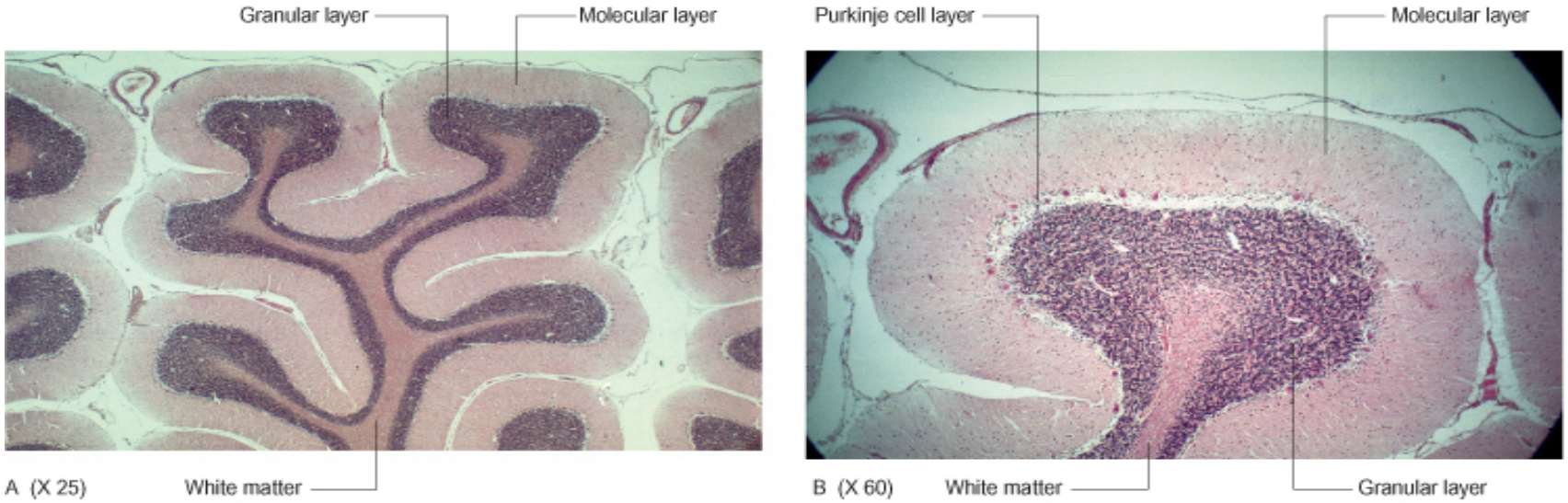
- *Molecular Layer*
- *Purkinje Cell Layer*
- *Granular Layer*

Corpus Medullare (Medullary Center)

Deep Cerebellar Nuclei

- *Fastigial Nuclei*
- *Emboliform Nucleus*
- *Globose Nucleus*
- *Dentate Nucleus*

Transverse sections of cerebellar folia



Transverse sections of cerebellar folia showing the layers of the cerebellar cortex.

The cerebellar cortex

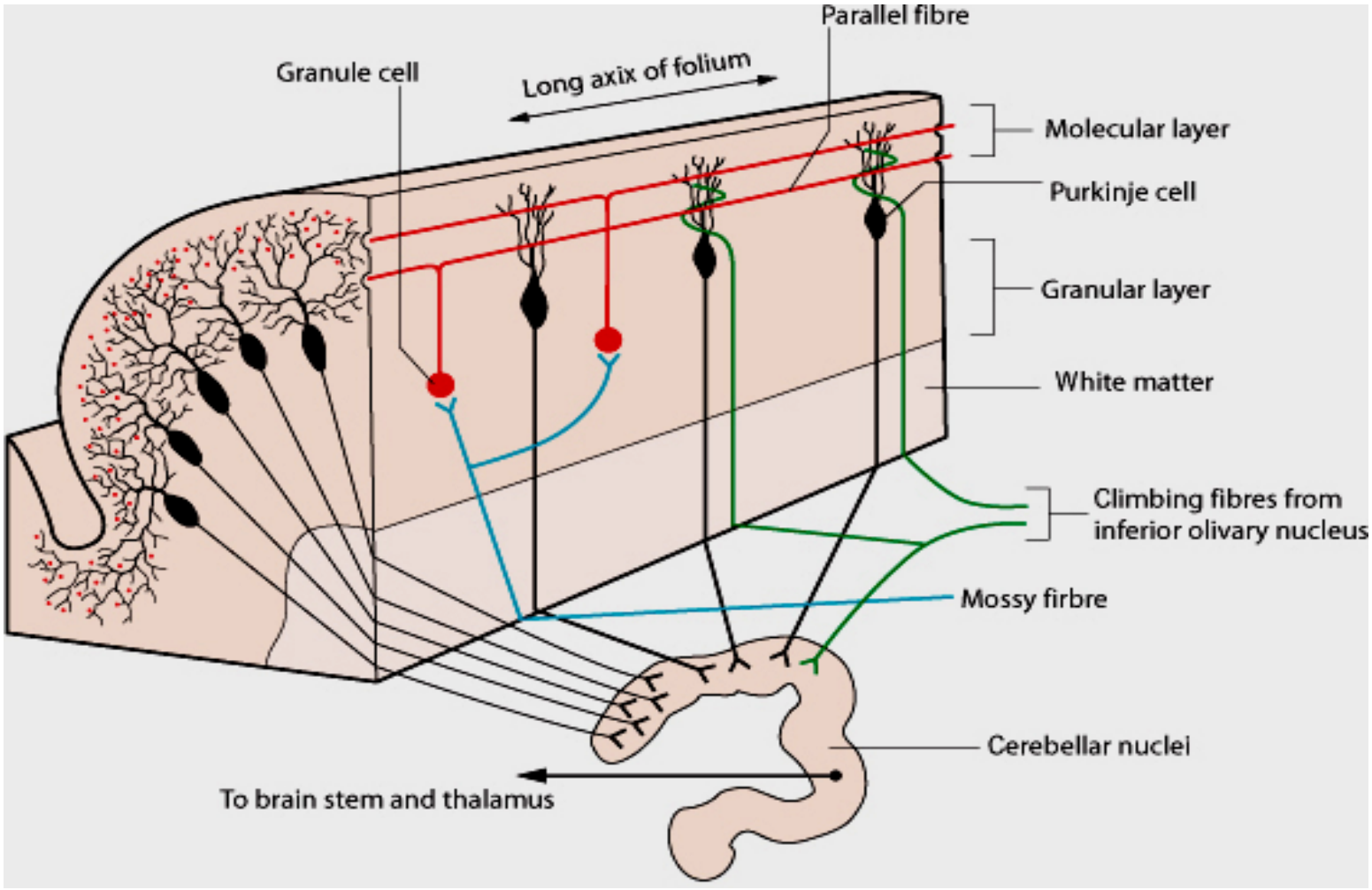
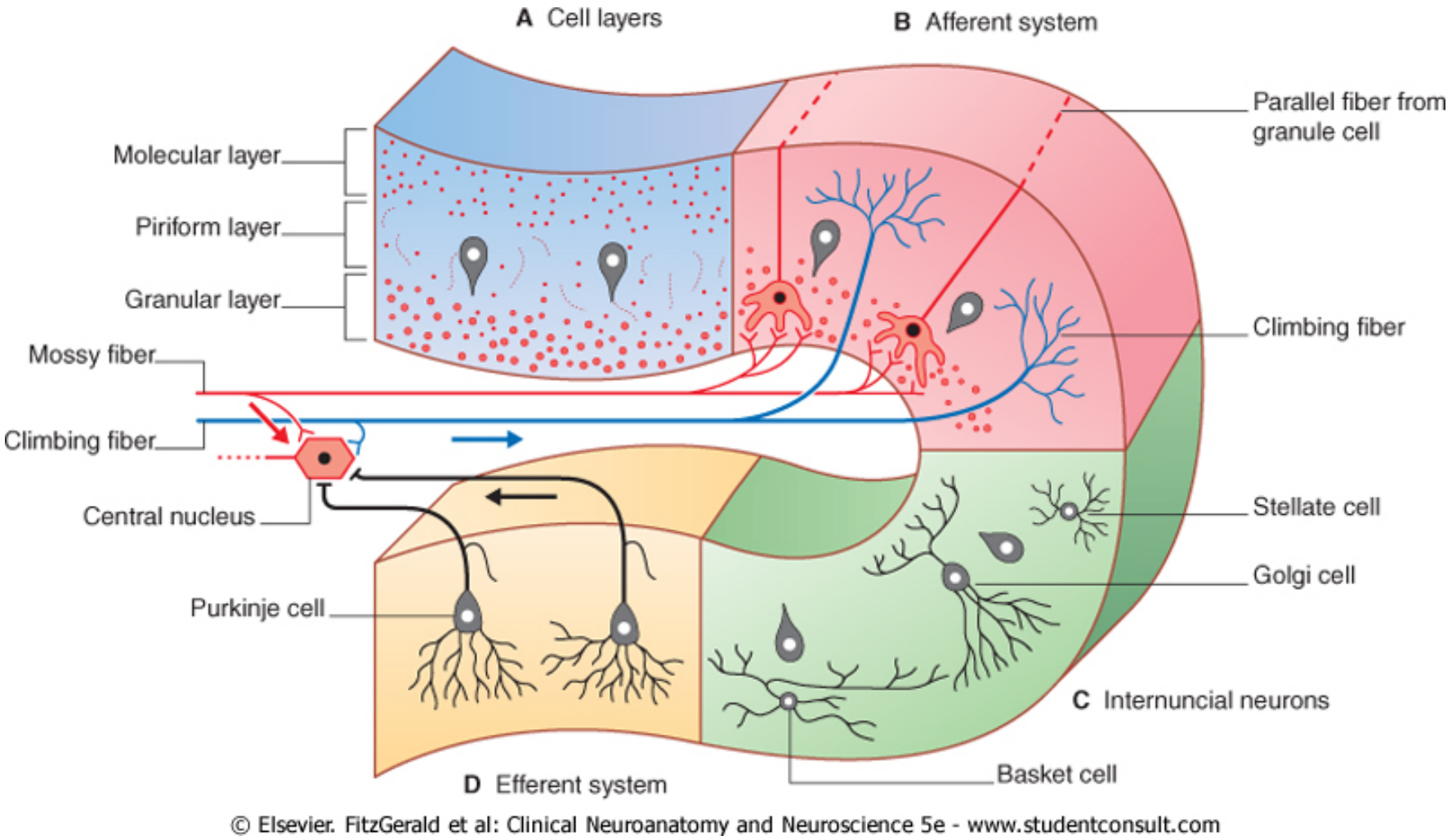


Diagram shows afferent and efferent connections and their relationships to the principal cells of the cerebellar cortex.

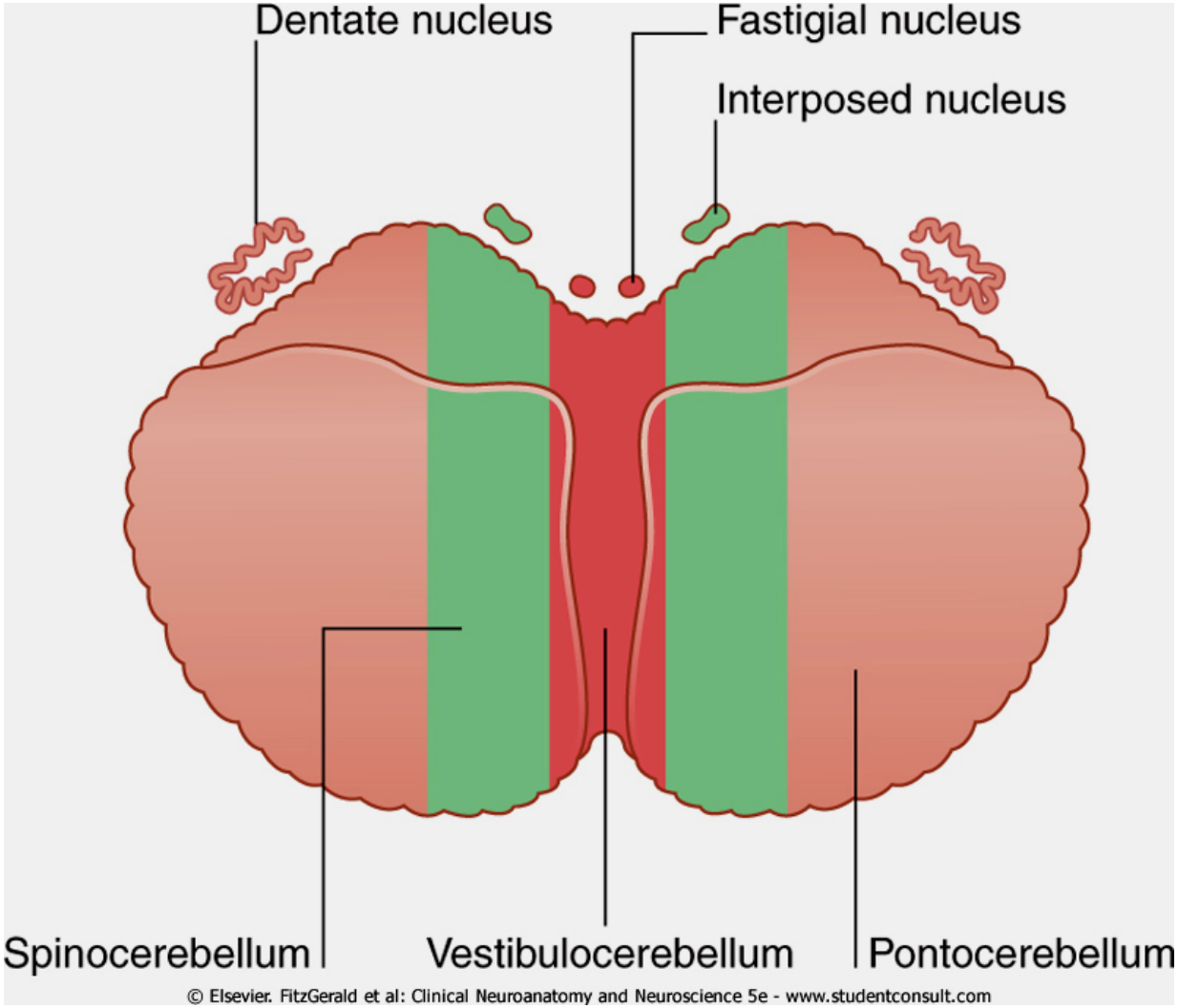


Cerebellar cortex .**A** Cell layers **B** Afferent system .**C** Internuncial neurons .**D** Efferent system .

Three functional divisions

vestibulocerebellum

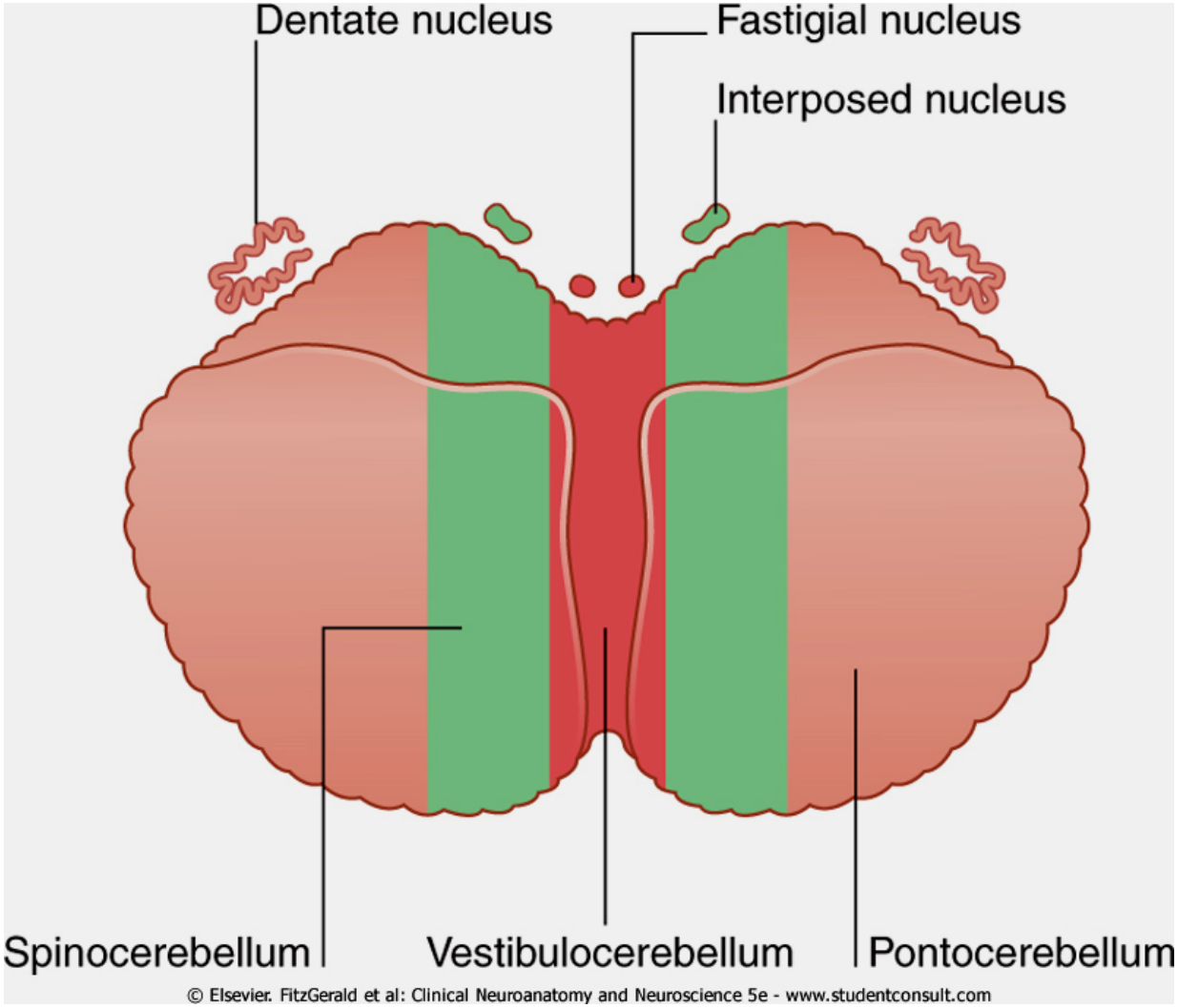
The median strip contains the cortex of the vermis, together with the **fastigial nucleus** in the white matter close to the nodule This strip is the *vestibulocerebellum* ;it has two-way connections with the vestibular nucleus. It controls the responses of that nucleus to signals from the vestibular labyrinth. The fastigial nucleus also projects to the gaze centers of the brainstem



Three functional divisions

spinocerebellum

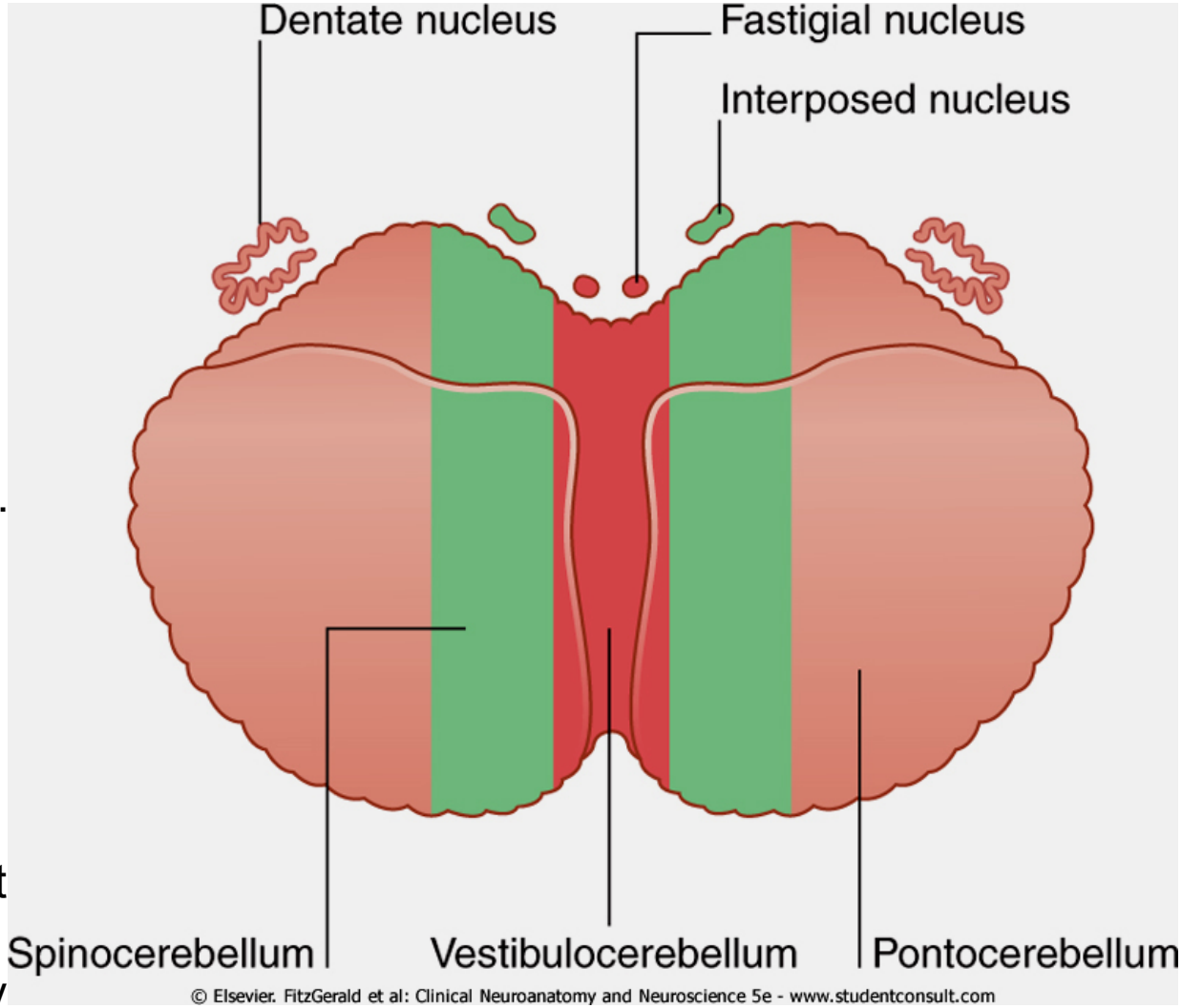
A paramedian strip, the *spinocerebellum* , includes the paravermal cortex and the **globose** and **emboliform nuclei.** The two nuclei are together called the **interposed nucleus.** The spinocerebellum is rich in spinocerebellar connections. It is involved in the control of posture and gait .



Three functional divisions

Neocerebellum

The remaining, lateral strip is much the largest and takes in the wrinkled **dentate nucleus.** This strip is the P*ontocerebellum* , because it receives a massive input from the contralateral nuclei pontis. It is also called the **neocerebellum**,because the nuclei pontis convey information from large areas of the cerebral neocortex (phylogenetically the most recent). The neocerebellum is uniquely large in the human brain .



Three functional divisions

- **Archicerebellum (Vestibulo- cerebellum)**

  -Flocculonodular lobe & Lingula

  - Connections with the vestibular system for balance, equilibrium

- **Paleocerebellum (Spino-cerebellum)**

  -Anterior lobe & pyramid & uvula

  -receives prorioception & tactile

  - Propulsed stereotyped movements (swimming & walking)

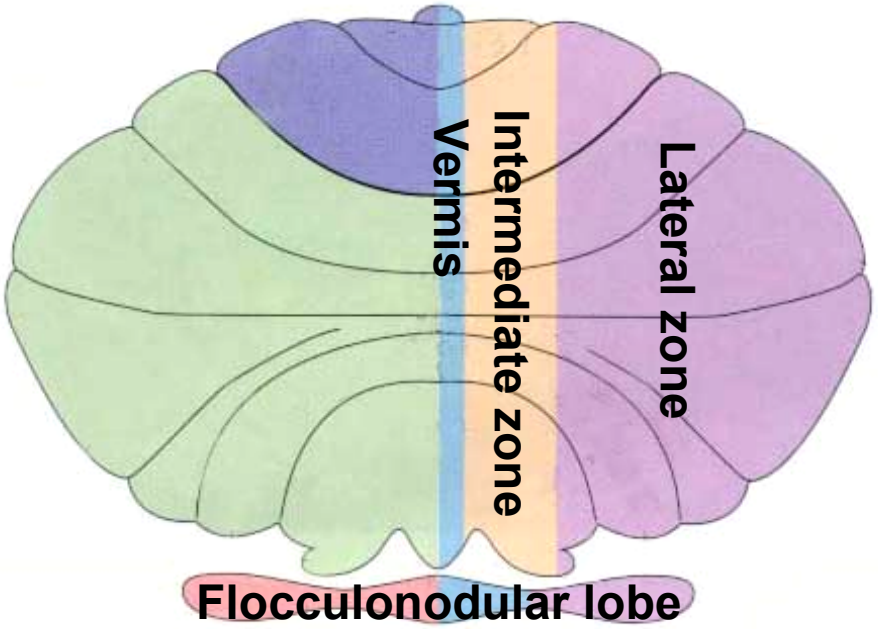
- **Cerebrocerebellum (Neo-cerebellum)**

  -Middle lobe (posterior) except pyramid & uvula

  - Co-ordination of movements

Three functional divisions

- **Vestibulocerebellum**
  Archicerebellum
  Flocculonodular lobe
- **Spinocerebellum**
  - Paleocerebellum
  - Vermis and intermediate zone
- **Cerebrocerebellum**
- Neocerebellum
  - Lateral zone



Connections and function of cerebellum

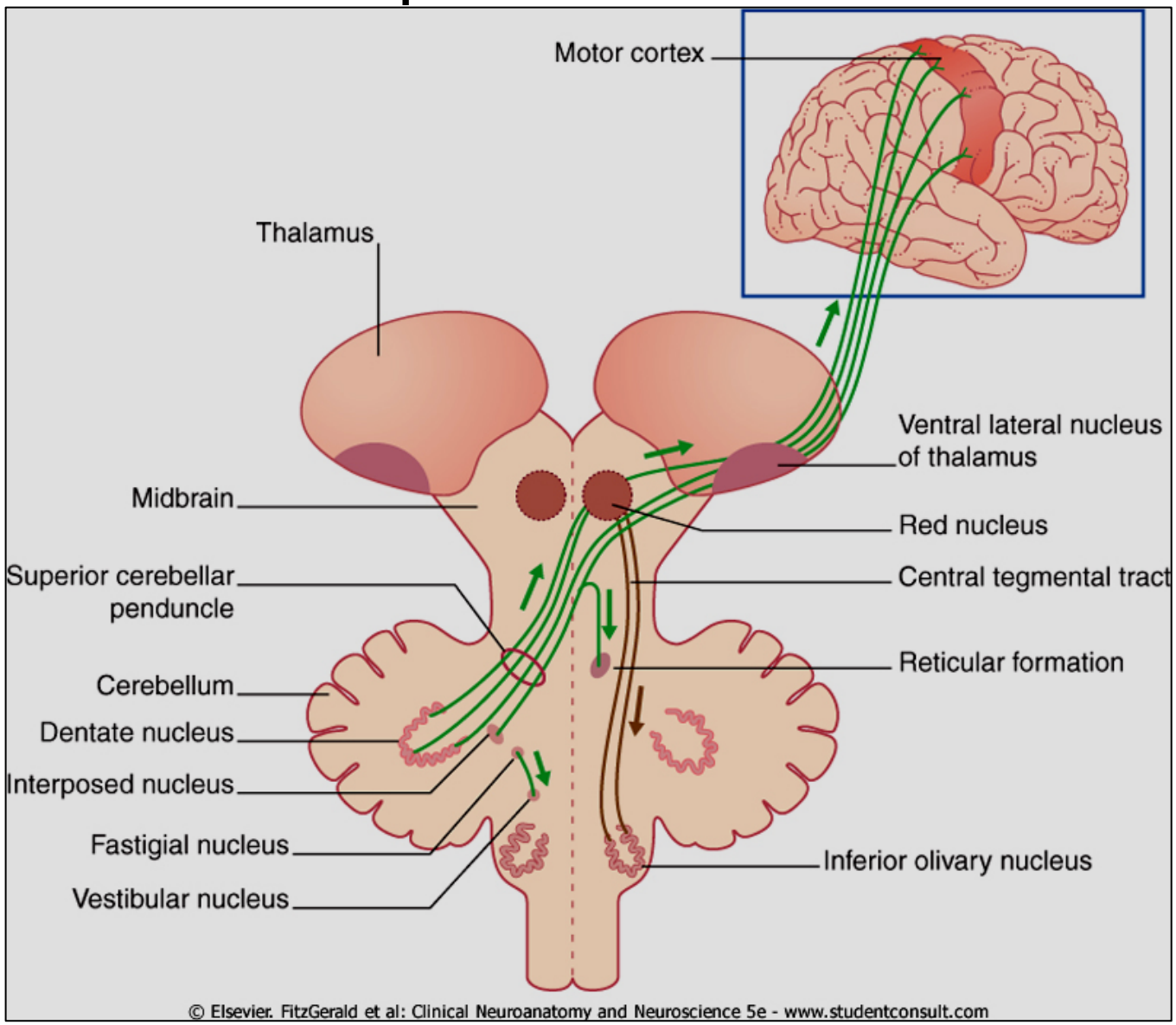
- **Efferents**:
  - Vermis projects to the fastigial nucleus → vestibular nuclei and reticular formation → vestibulospinal tract and reticulospinal tract → motor neurons of anterior horn
  - Intermediate zone projects to the interposed nuclei
    - Contralateral red nucleus → rubrospinal tract →motor neurons of anterior horn
    - Contralateral VI →cerebral cortex→ coticospinal tract→motor neurons of anterior horn
- Function: play an important role in control of muscle tone and coordination of muscle movement on the same side of the body

Connections and function of cerebellum

Cerebrocerebellum

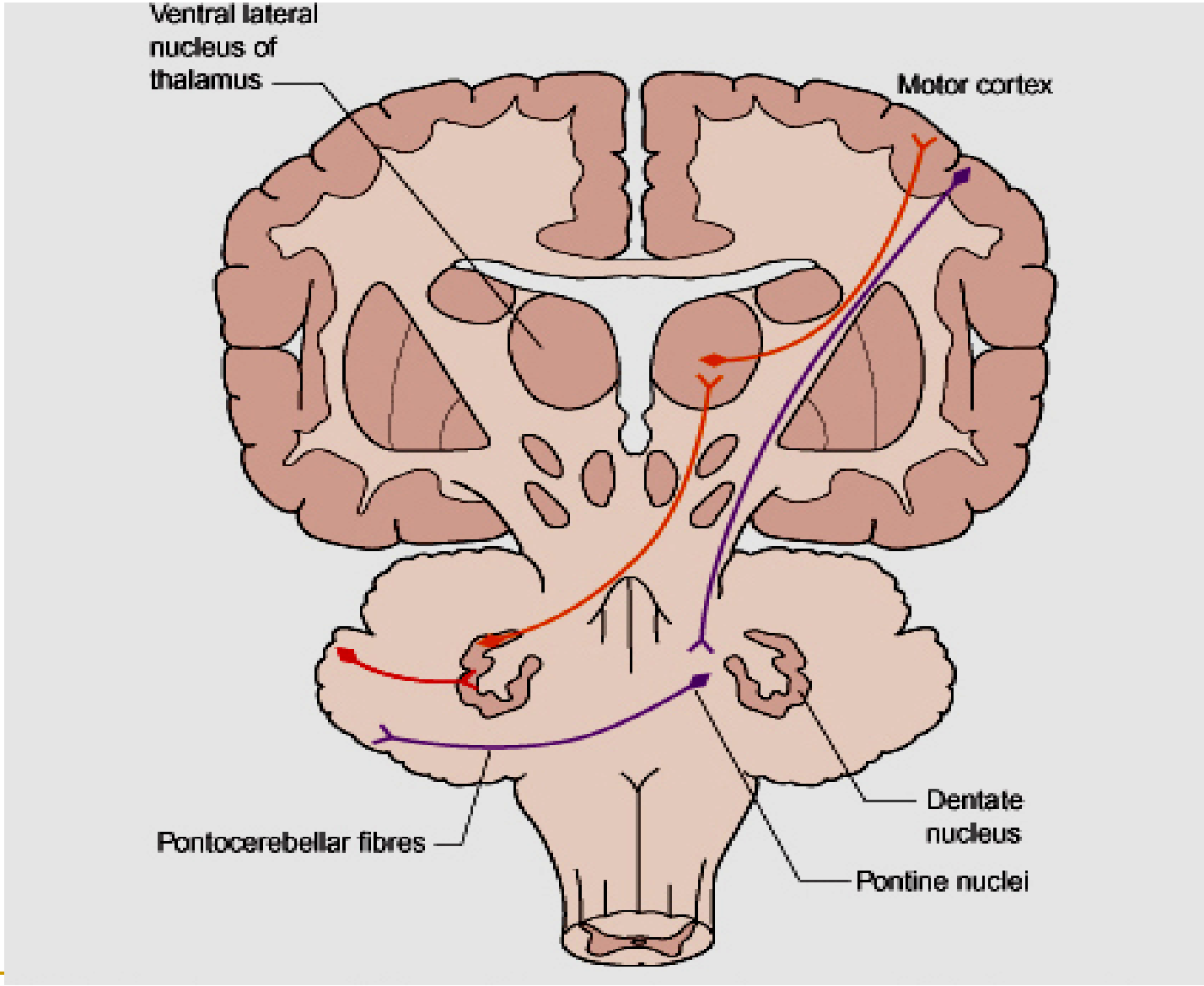
- Connections
  - **Afferents**: receives input from the cerebral cortex via a relay in pontine nuclei (Cortico-ponto-cerebellar fibers)
  - **Efferents**: projects to dentate nucleus → area 6 (primary motor cortex) → corticospinal tract → motor neurons of anterior horn
- Function: participates in planning movements

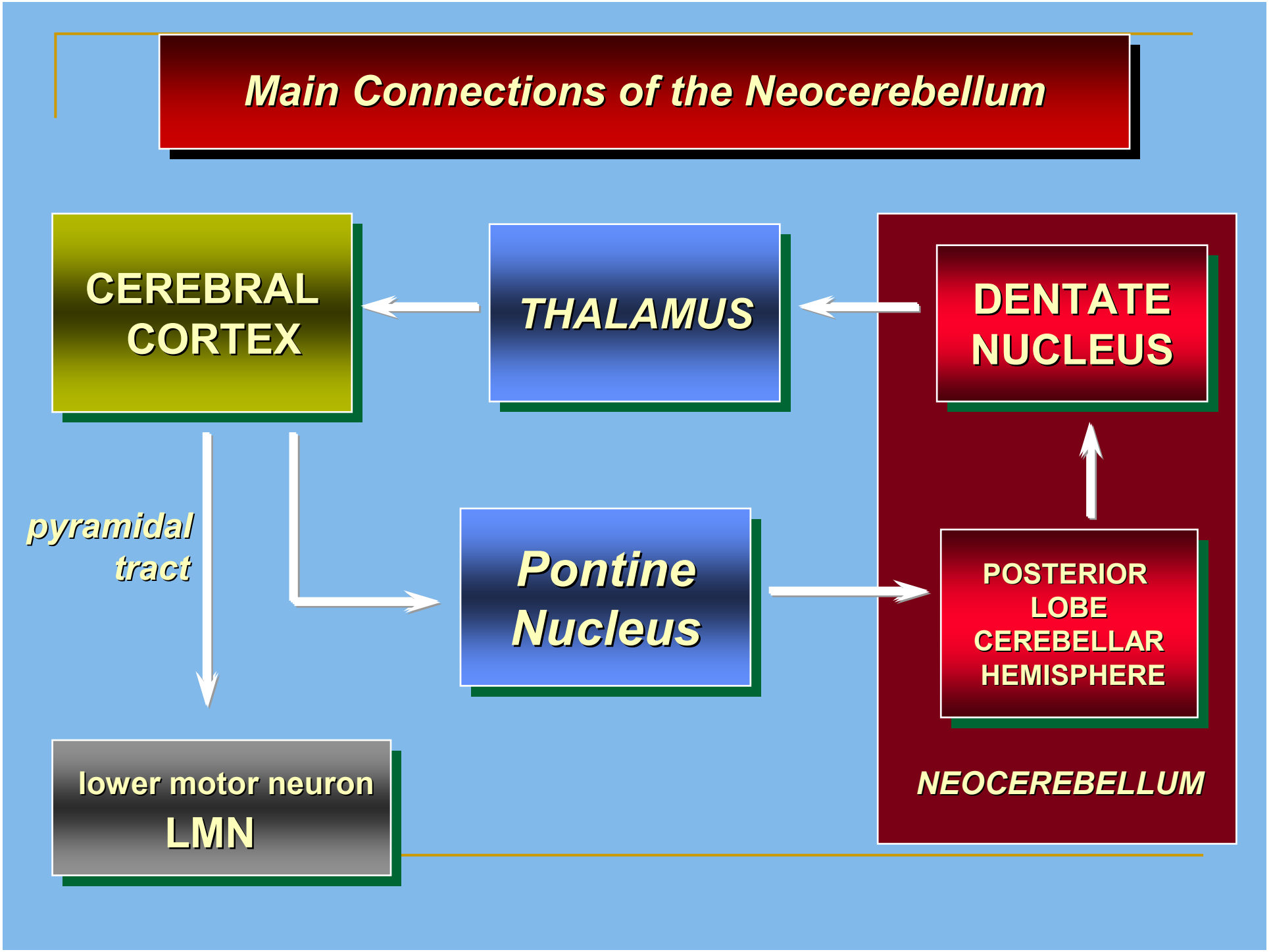
Principal cerebellar efferents.



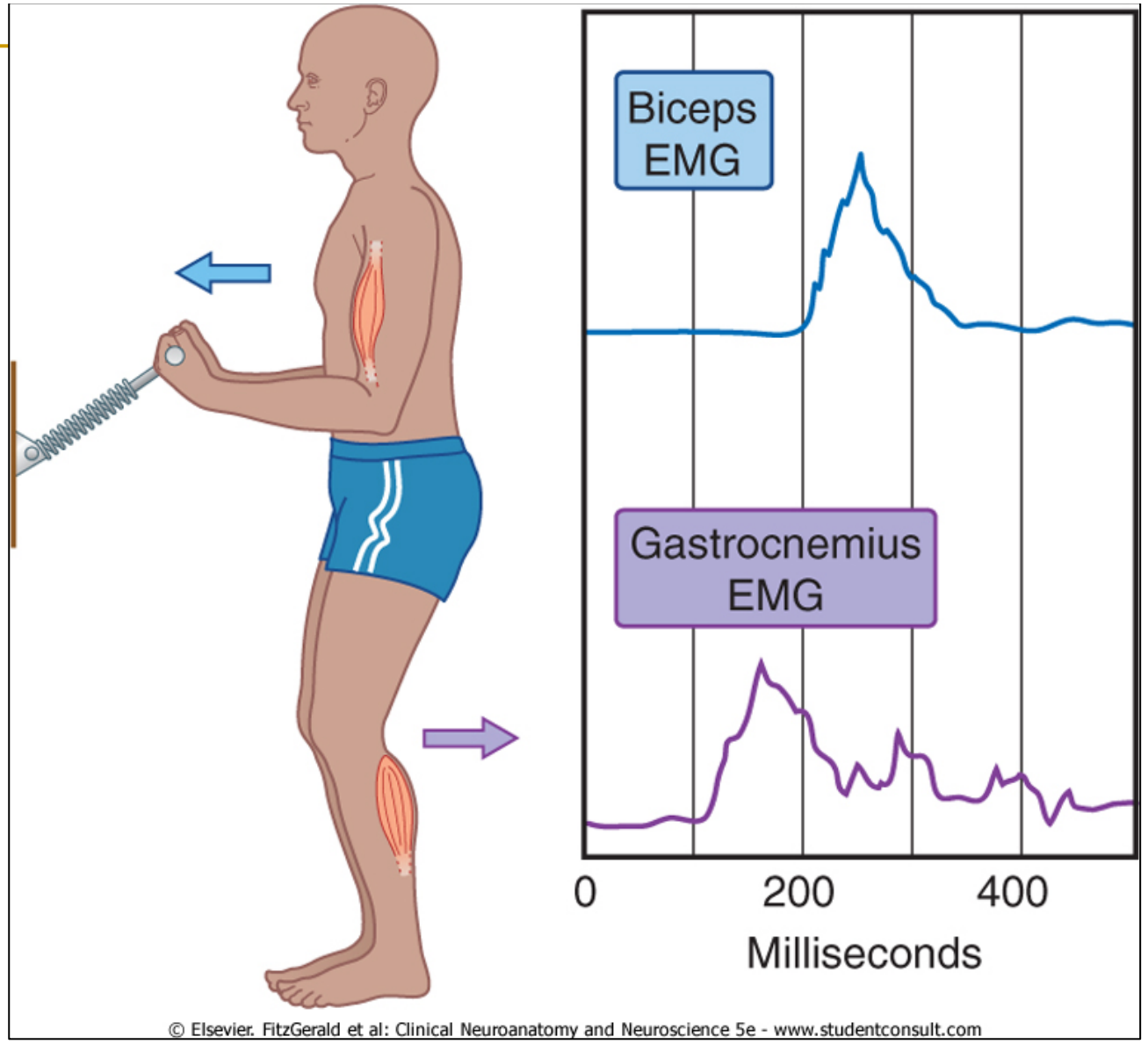
Arrows indicate directions of impulse conduction.

Connections of the neocerebellum.




Main Connections of the Neocerebellum
CEREBRAL CORTEX
THALAMUS
DENTATE NUCLEUS
pyramidal tract
Pontine Nucleus
POSTERIOR LOBE CEREBELLAR HEMISPHERE
NEOCEREBELLUM
lower motor neuron
LMN

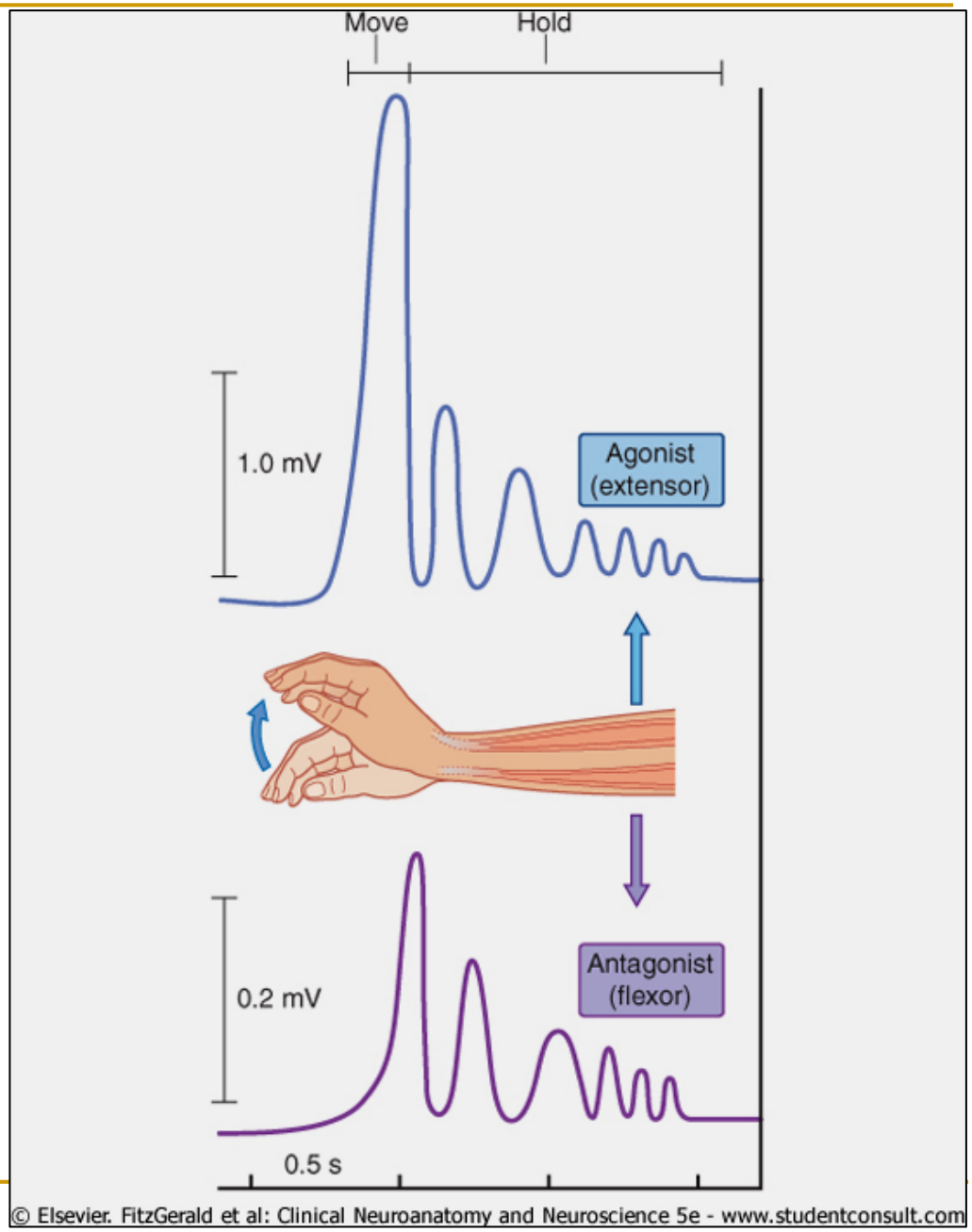
Postural stabilization



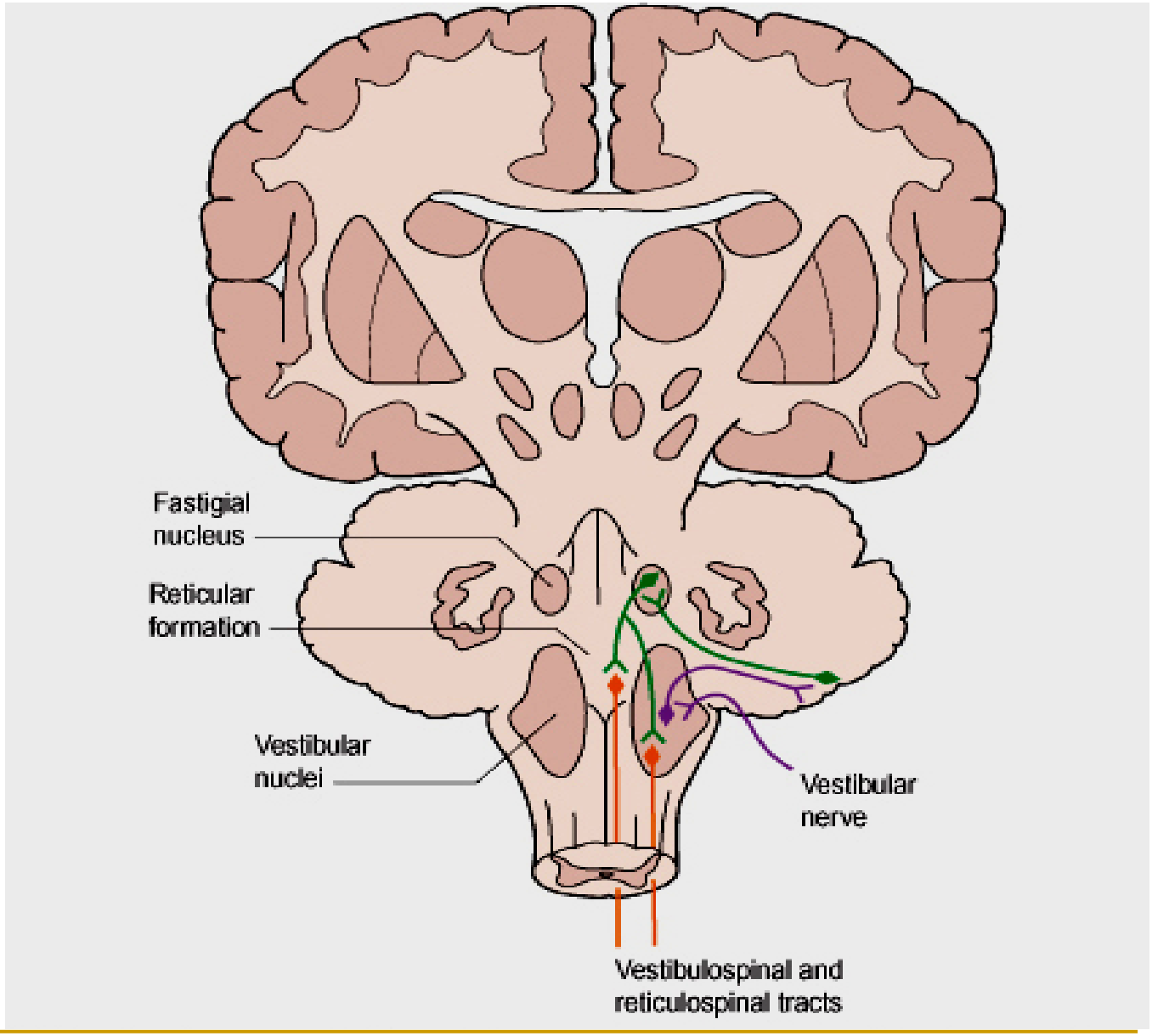
. The subject is pulling a stiff spring attached to the wall. Flexion of the elbow during contraction of biceps brachii tends to pull the trunk forward (arrow). This movement is prevented by equivalent contraction of the gastrocnemius, exerting downward pressure on the forefoot, which tends to thrust the trunk backward (arrow). Simultaneous electromyographic (EMG) recordings show that onset of (automatic) gastrocnemius contraction precedes voluntary biceps contraction by 80 ms.

Postural fixation

. The subject was instructed to perform sudden wrist extension and to briefly hold the extended posture. Electromyographic recordings show that wrist flexors come into action before completion of the movement. In the 'hold' position, note alternation of electrical activity between agonist and antagonist. Antagonist electromyographic activity is much weaker, as indicated by the scale bars on the left.

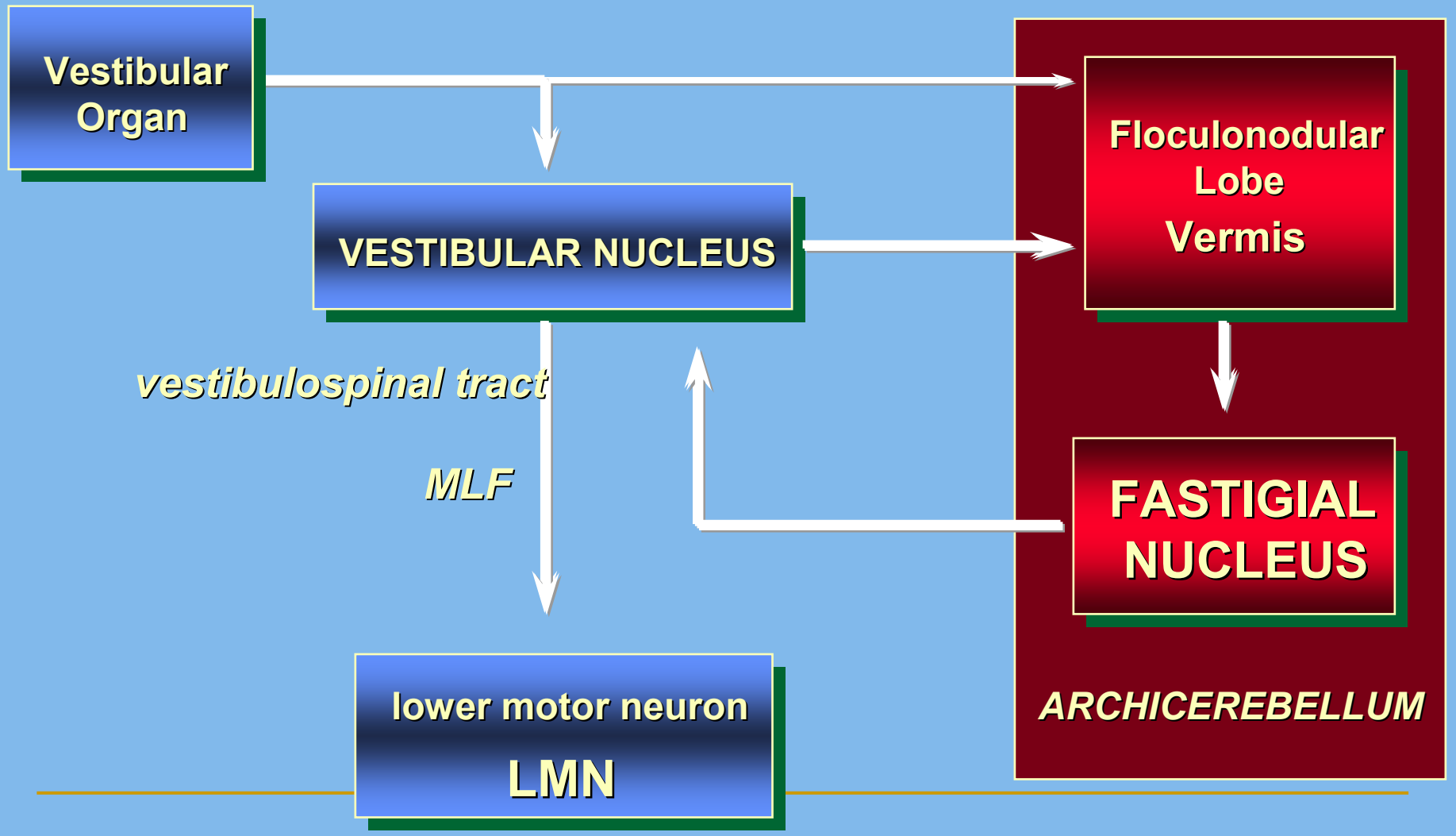


Connections of the archi-cerebellum (Vestibulo-cerebellum).



(Contralateral projections of the fastigial nucleus are not shown).

Main Connections of the Vestibulocerebellum

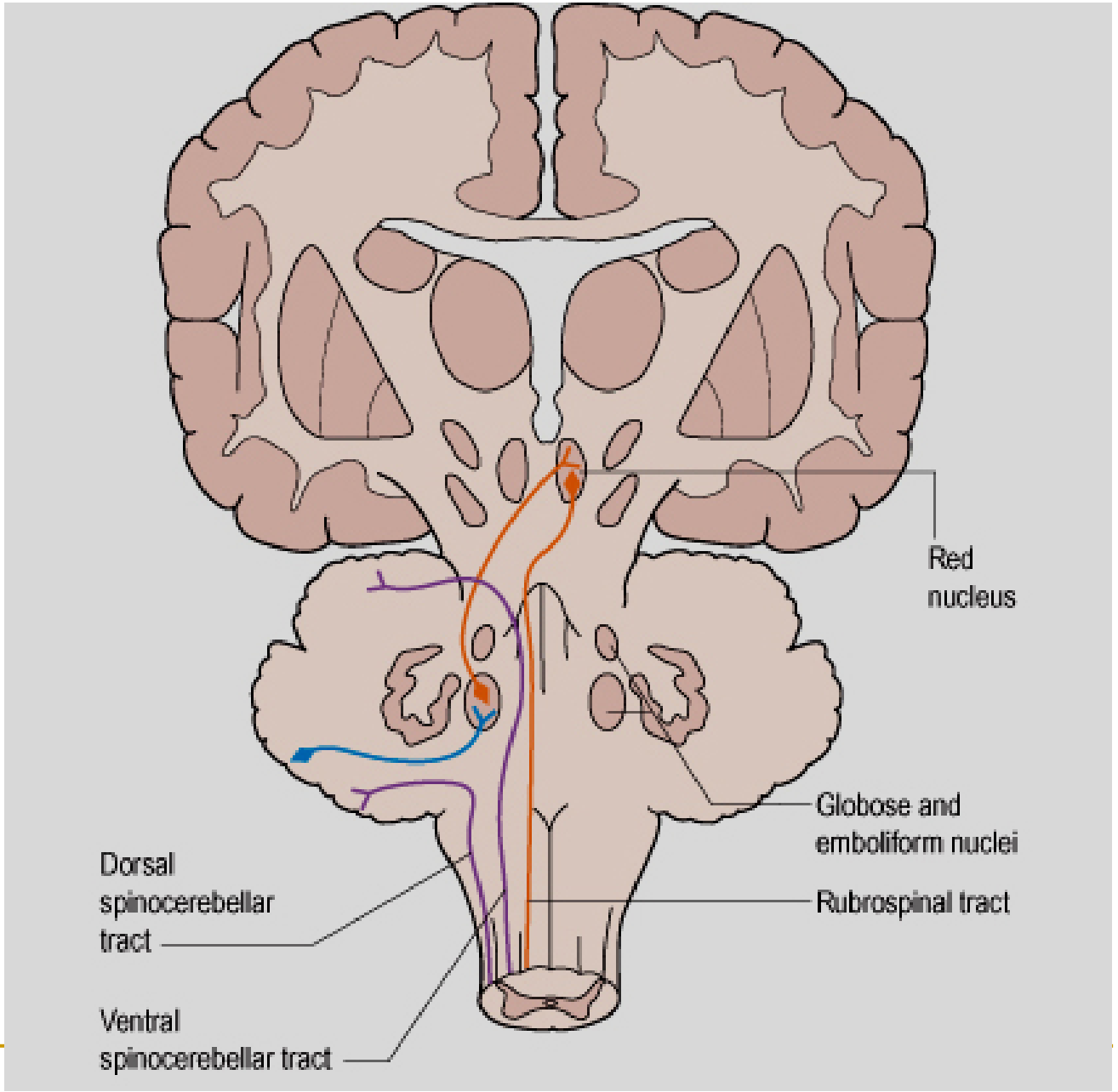


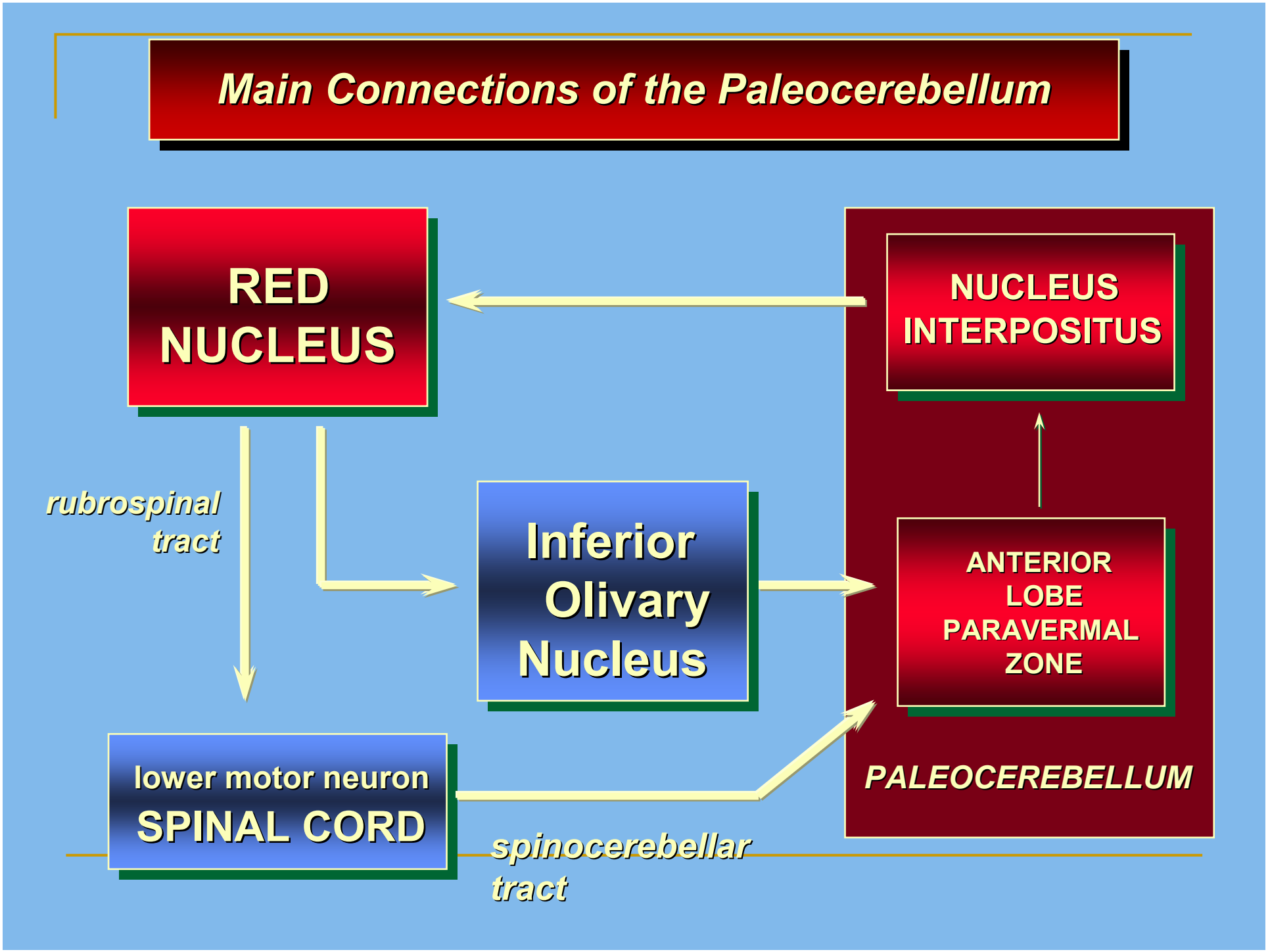
Connections and function of cerebellum

Vestibulocerebellum

- Connections
  - **Afferents**: receive input from vestibular nuclei and primary vestibular area
  - **Efferents**: projects to the vestibular nucleus → vestibulospinal tract and medial longitudinal fasciculus → motor neurons of anterior horn
- Function: involved in eye movements and maintain balance

Connections of the paleocerebellum.

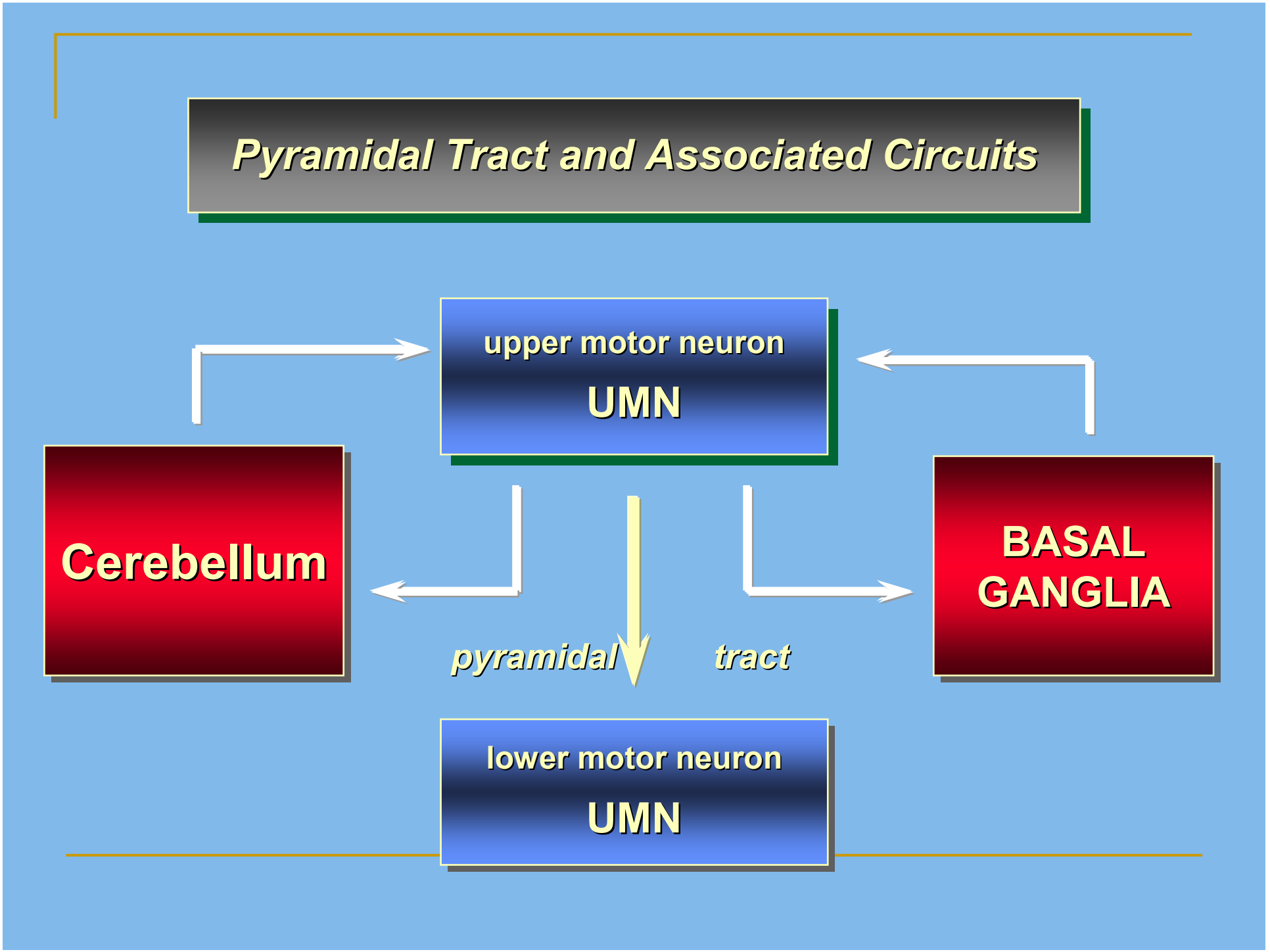


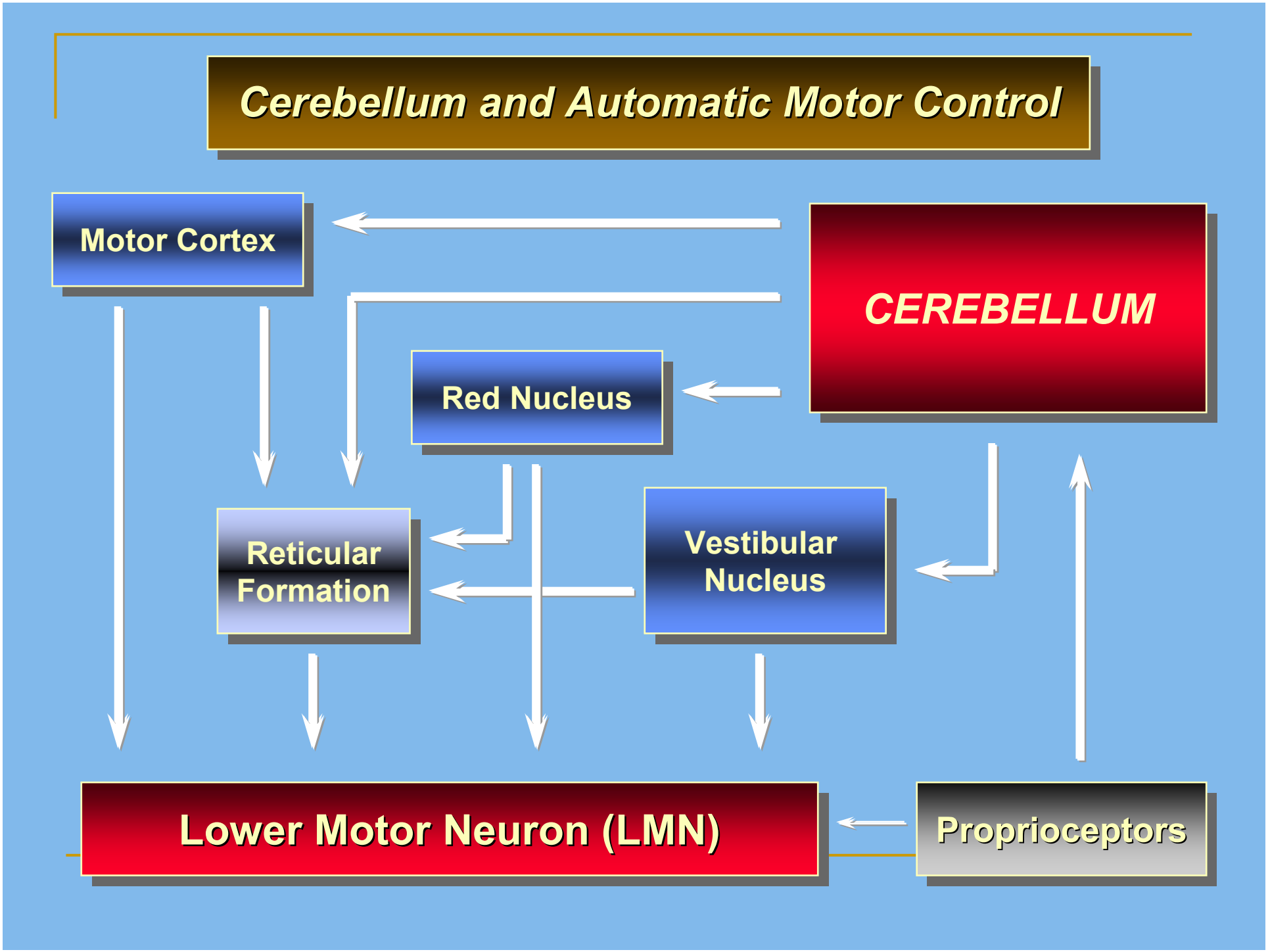

Main Connections of the Paleocerebellum
RED NUCLEUS
NUCLEUS INTERPOSITUS
rubrospinal tract
Inferior Olivary Nucleus
ANTERIOR LOBE PARAVERMAL ZONE
lower motor neuron
SPINAL CORD
PALEOCEREBELLUM
spinocerebellar tract

Connections and function of cerebellum

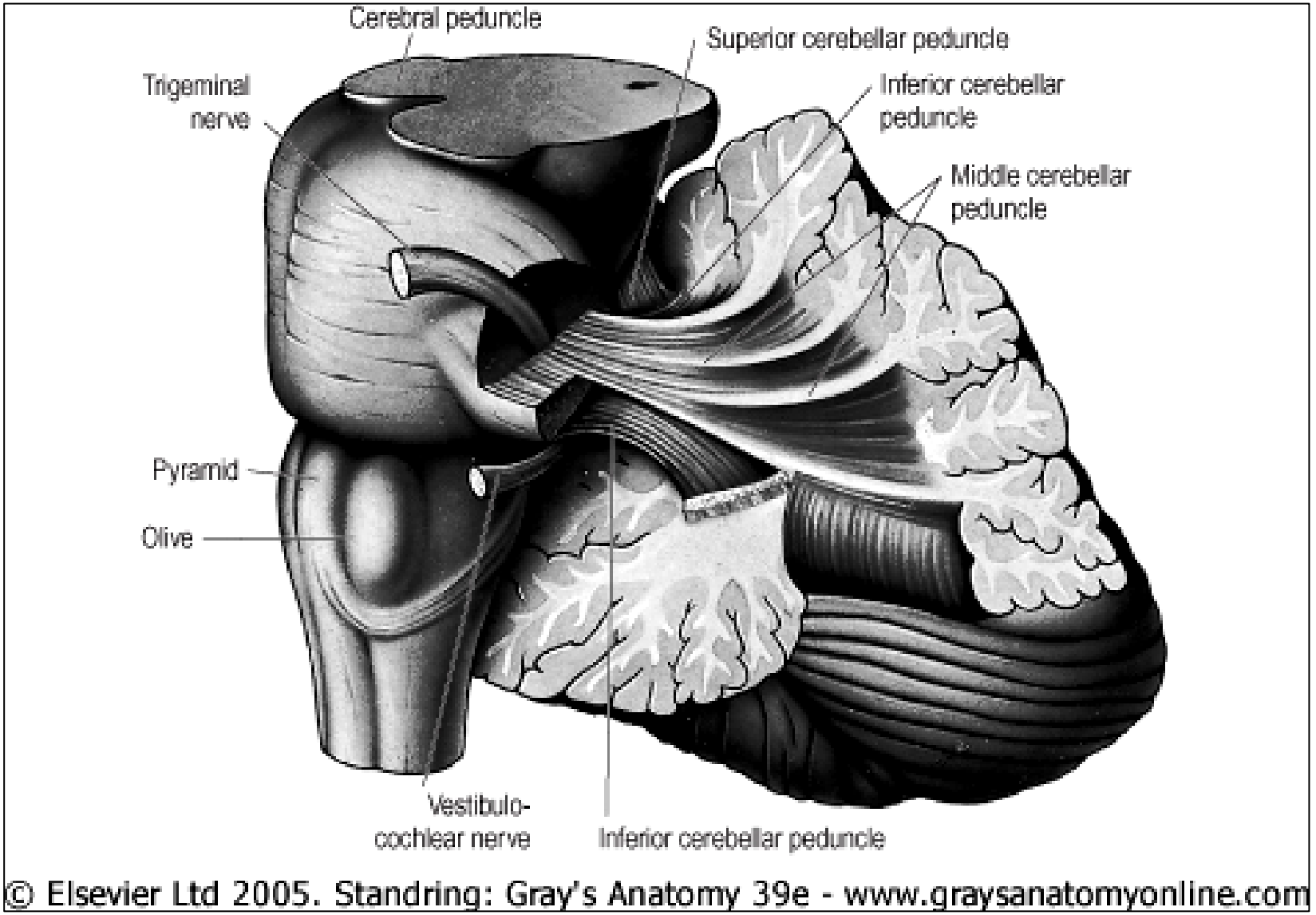
Spinocerebellum

- Connnection
  - **Afferents**: receive somatic sensory information via spinocerebellar tracts


Pyramidal Tract and Associated Circuits
upper motor neuron
UMN
Cerebellum
BASAL GANGLIA
pyramidal
tract
lower motor neuron
UMN


Cerebellum and Automatic Motor Control
Motor Cortex
CEREBELLUM
Red Nucleus
Reticular Formation
Vestibular Nucleus
Lower Motor Neuron (LMN)
Proprioceptors

Cerebellar Peduncles



Dissection of the left cerebellar hemisphere and its peduncles.

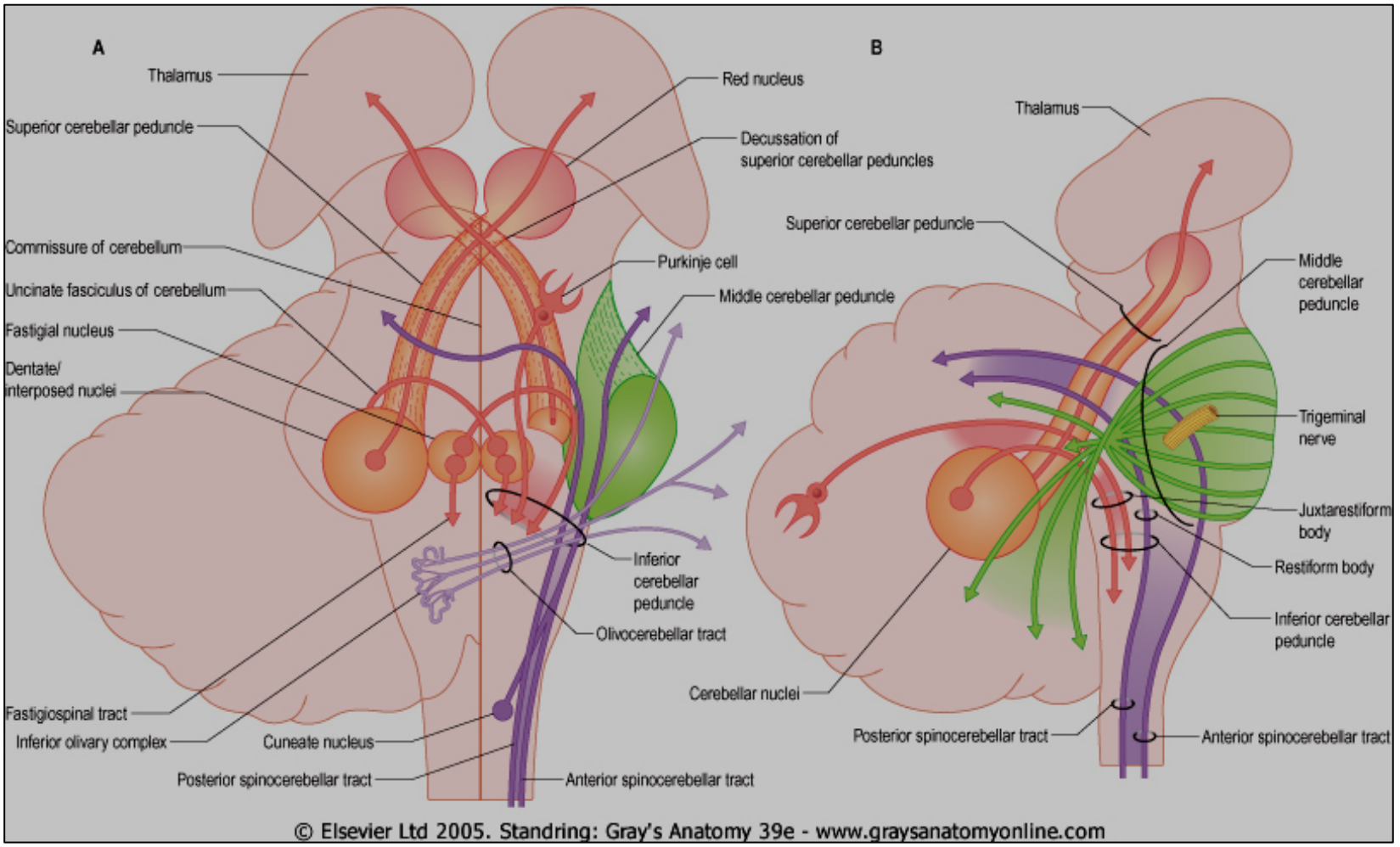


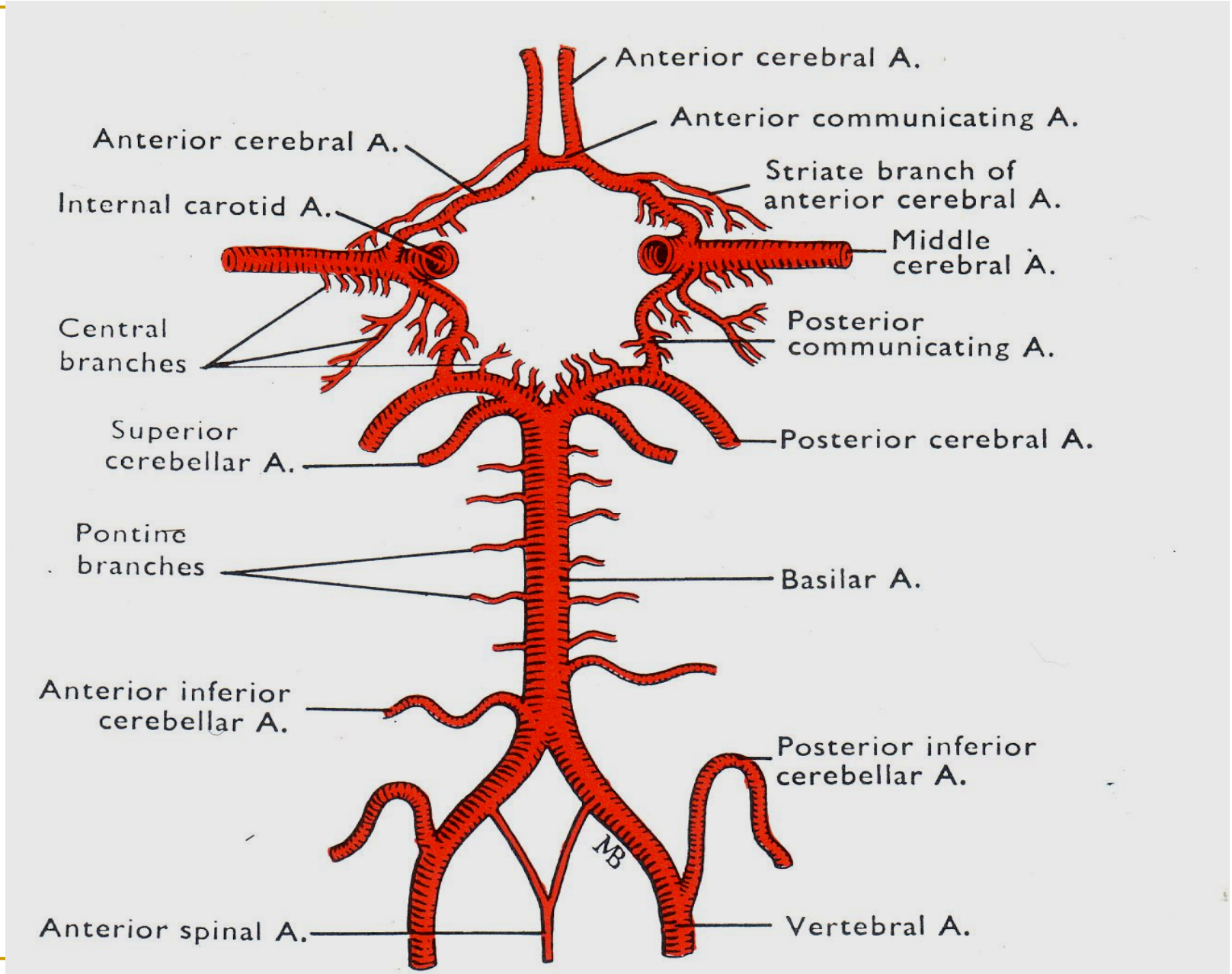
Diagram illustrating the composition of the cerebellar peduncles. A, dorsal view. B, lateral view.

Tractology of the cerebellum (Cerebellar Peduncles)

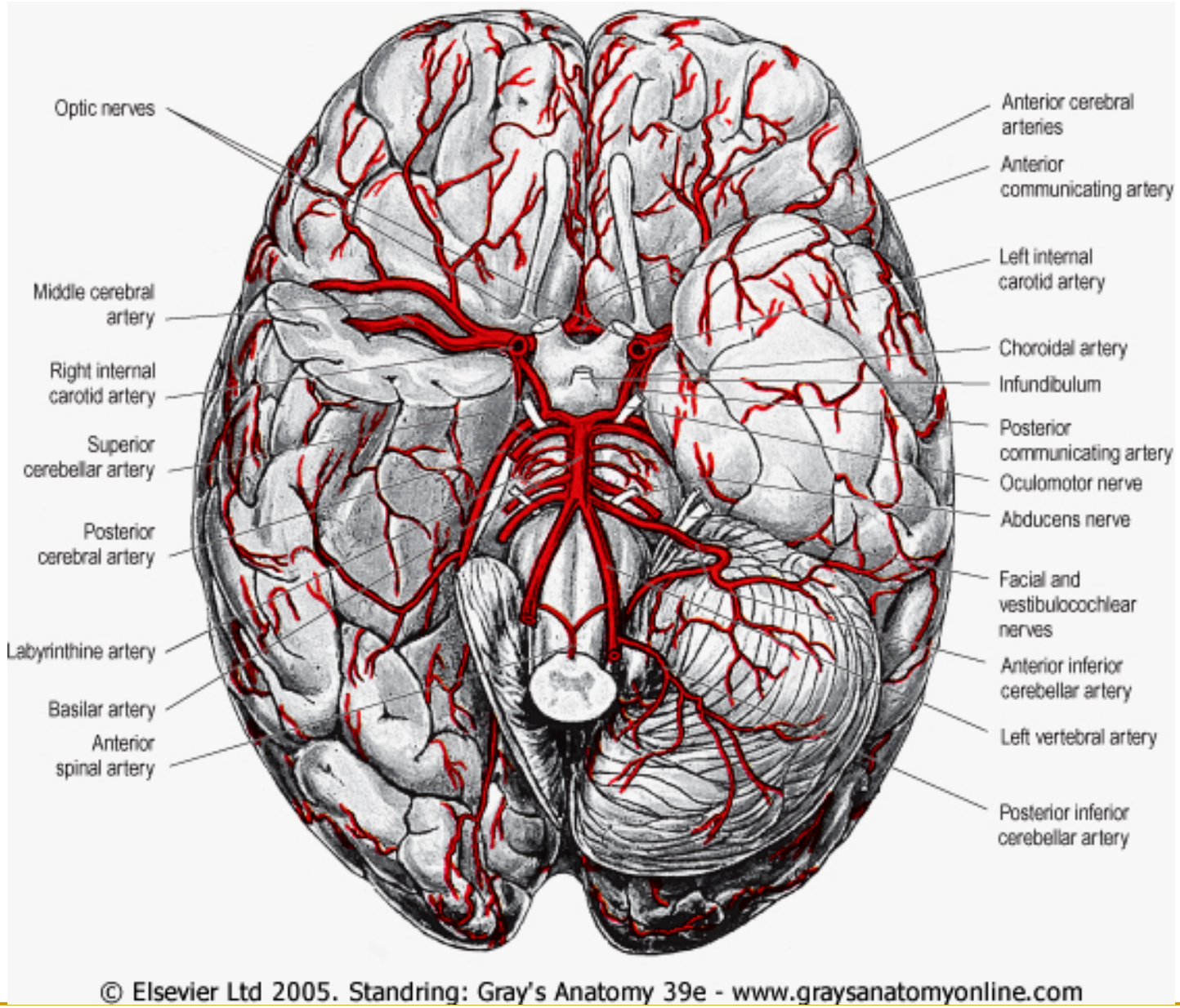
	Inferior cerebellar peduncles	*Middle cerebellar peduncles*	*Superior cerebellar peduncles*
Afferents	1. Posterior spinocerebellar 2. Cuneo-cerebellar (posterior external actuate fibers) 3. Olivo-cerebellar 4. Parolivo-cerebellar 5. Vestibulo-cerebellar 6. Reticulo-cerebellar 7. Anterior external arcuate fibers	1. Pontocerebellar	1. Anterior spinocerebellar 2. Tecto-cerebellar
Efferents	1. Cerebello-olivary 2. Cerebello-vestibular 3. Cerebello-reticular	1. Cerebello-pontine	1. Dentato-rubral 2. Dentato-thalamic (IVN) 3. Dentato-olivary 4. Dentato-reticular

Blood Supply of the cerebellum

- The **posterior inferior cerebellar artery (from vertebral artery)** supplies the cerebellum &the side of the medulla
- The **anterior inferior cerebellar** and **superior cerebellar arteries (both arise from basilar artery)** supply the cerebellum& side of the pons



The arteries on the base of the brain.

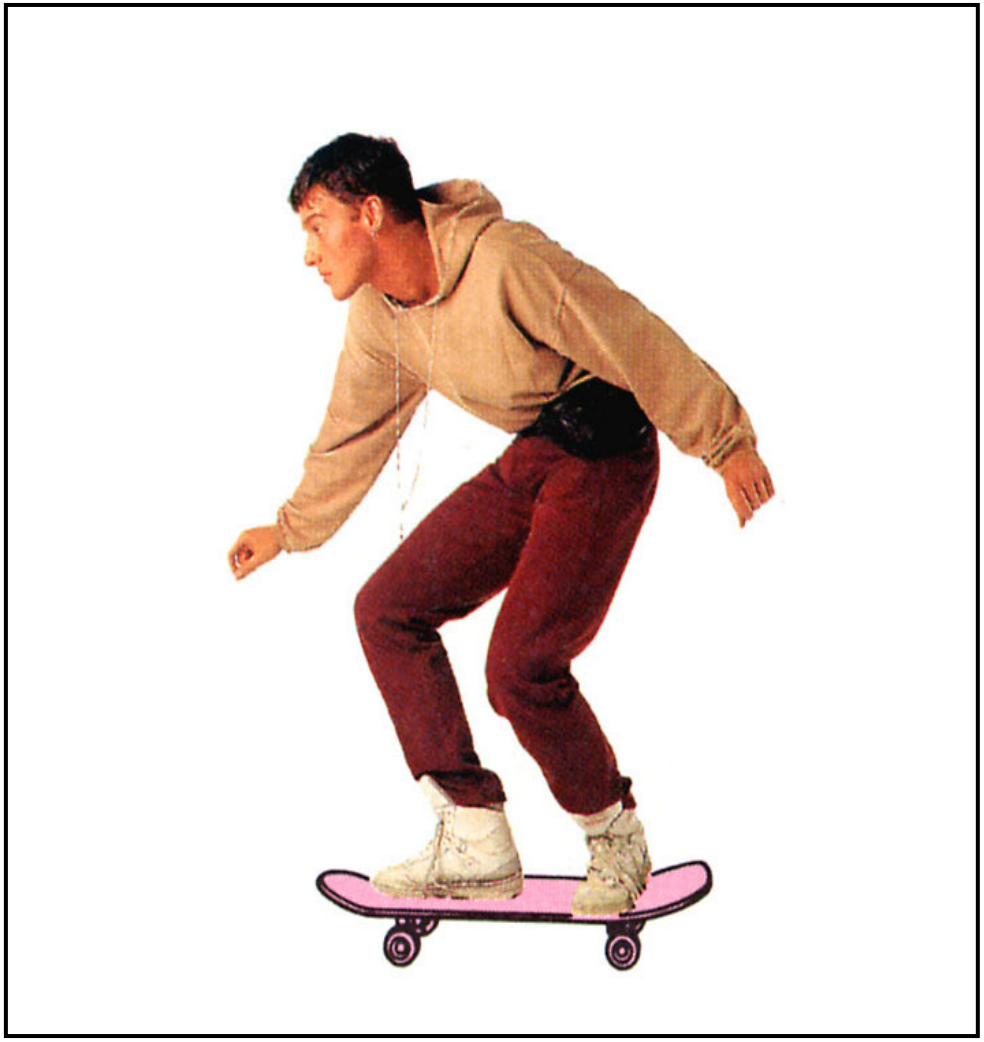


The arteries on the base of the brain.

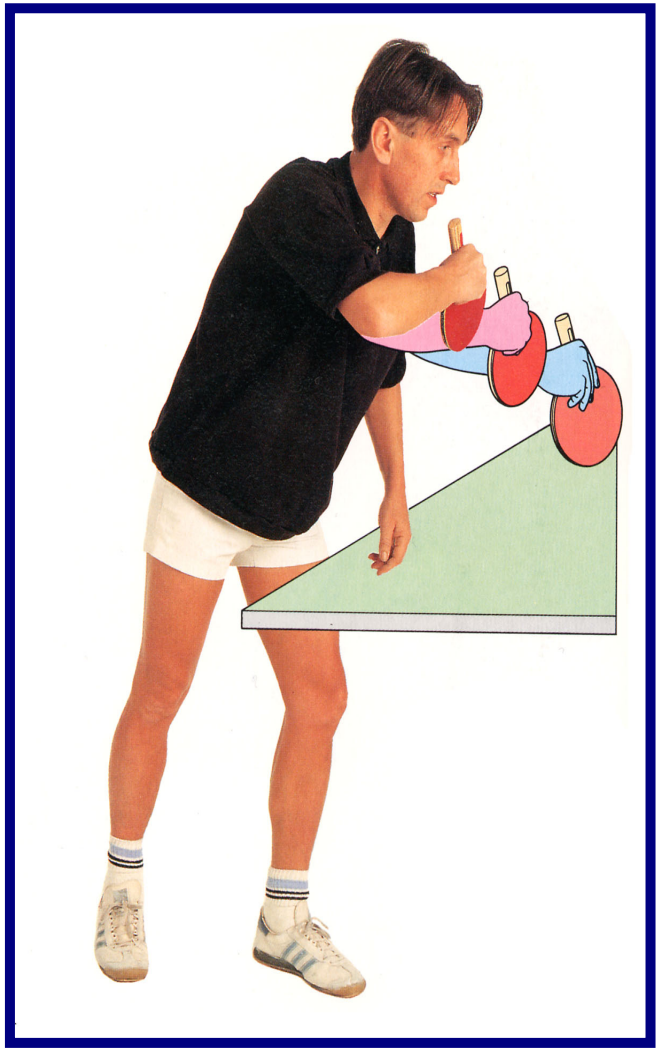
Function of the cerebellum

- ***Maintenance of Equilibrium***
  - *balance, posture, eye movement*
- ***Coordination of half-automatic movement of walking and posture maintenace***
  - *posture, gait*
- ***Adjustment of Muscle Tone***
- ***Motor Learning – Motor Skills***
- ***Cognitive Function***

Balance



Motor Skills



Cerebellum Clinical syndromes

Archicerebellar Lesion: as in medulloblastoma: Truncal ataxia

Paleocerebellar Lesion: gait ataxia

Neocerebellar Lesion: incoordination of voluntary movement, hypotonia, ataxia, tremor

-Ataxia: incoordination of movement

- decomposition of movement, Staccato speech & dysarthria

- dysmetria, past-pointing

- dysdiadokokinesia

(inability to carry out alternating movements with rapidity & regularity)

- rebound phenomenon of Holmes

- gait ataxia, truncal ataxia, titubation *(rythmic rocking tremors of the trunk and head)*

-Intention Tremor *due to incoordination of movements*

-Hypotonia, without weakness

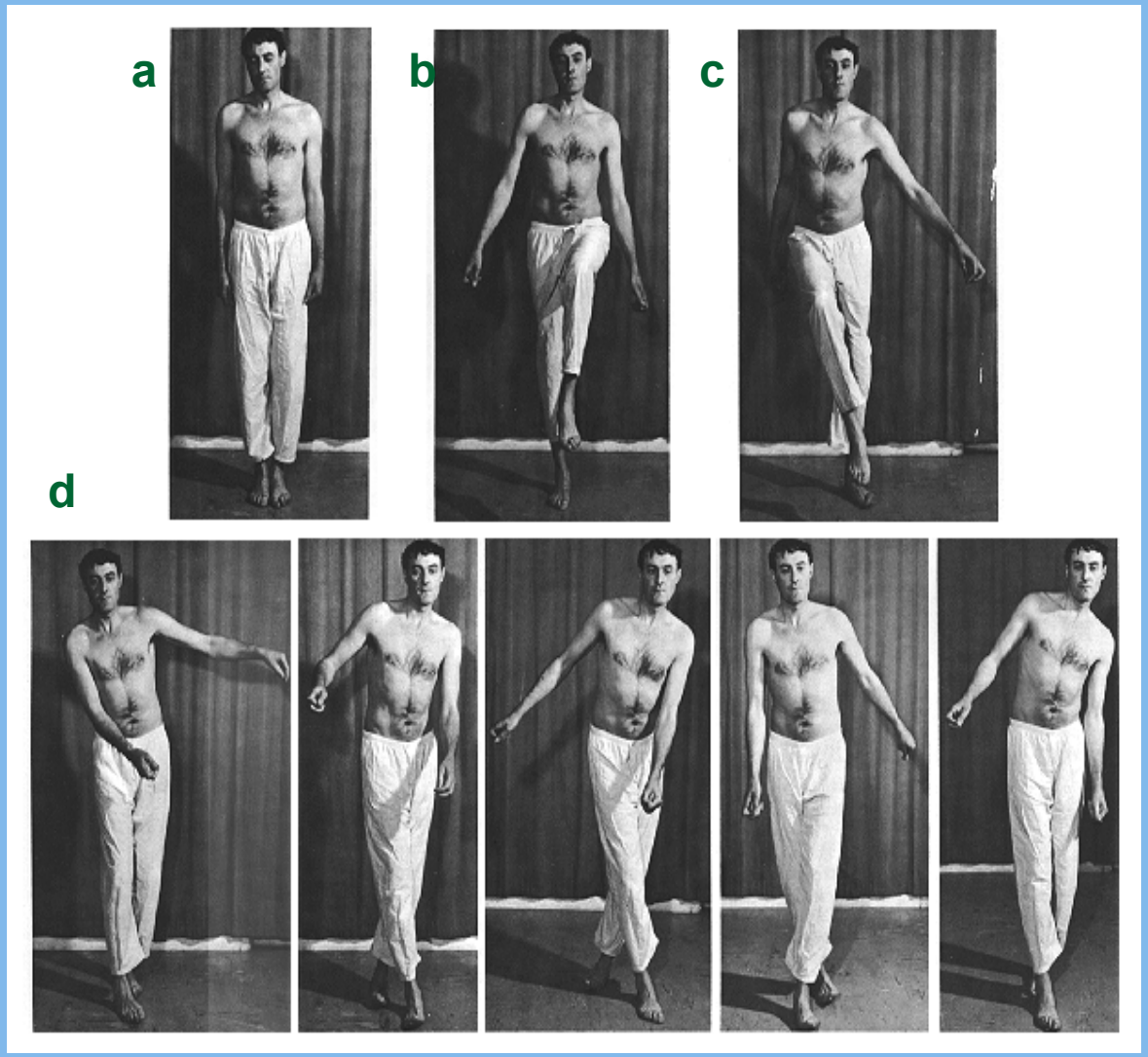
-Nystagmus & Disequilibrium

Cerebellar Syndrome

- **From this information the cerebellum *coordinates the range, velocity and strength of contractions* to produce steady volitional movements and steady volitional postures.**
- ***Incoordination (ataxia)* is the main feature of cerebellar dysfunction. An easy way to remember a *cerebellar syndrome* is to imagine a drunken person who cannot *coordinate* any volitional movement. He sways when standing, reels when walking, slurs words when talking and has jerky eye movements when looking.**
- **In addition, the muscles are loose and floppy (*hypotonia*).**

Thus, *ataxia, dysarthria, nystagmus and hypotonia* are the four major clinical signs of the cerebellar syndrome.

Posture
Gait – Ataxia
Tremor



Cerebellar Ataxia

Ataxic gait and position: Left cerebellar tumor

a. Sways to the right in standing position

b. Steady on the right leg

c. Unsteady on the left leg

d. ataxic gait

Cerebellar Medulloblastoma

Cerebellar tumors on vermis

- Truncal Ataxia
- Frequent Falling

The child in this picture:

- would not try to stand unsupported
- would not let go of the bed rail if she was stood on the floor.

Cerebellar medulloblastoma

Thanks

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